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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

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Pattern Varnishes and Colouring

To the best of our knowledge, no research work of British origin has been published on the subject of varnishing patterns. There is, of course, the Standard Recommendations as to the colour to be used. Because of recent developments in foundry practice, it is becoming more and more urgent that more knowledge should become available as to the actual properties of the varnished surfaces of patterns. Elsewhere in this issue we publish a translation of a Paper on this by Mr. George Godel, read before the annual meeting of the Association Technique de Fonderie. It discloses the framework of research necessary to evaluate the quality of various types of coatings used for the protection of patterns during their sojourn in the foundry. One phase not dealt with, which has particular interest for many foundries tucked away in various corners of the empire, is inhibition against attack by white ants, whilst remaining in the pattern store. Whether the particular treatment used for this purpose could be correlated with those essential for protection against damp sand is a matter for the paint specialists. The requirements for the foundry are simple and well defined. Varnishes must be waterproof so as to prevent moisture reaching the actual wood. It must be able to withstand the abrasive action of the sand. It must not be sticky, as otherwise grains of sand would adhere to it and prevent proper stripping, and, finally, it must be elastic to follow any swelling of the pattern should this occur.

The tests used in France are simple and thoroughly practical; they should be confirmed and correlated with the varnishes currently used in British practice.

Mr. Godel's ideas for standardising are worth careful study. He indicates "stopping off" and "core prints" by the same colour, with the object of simplification, and advocates the use of a pre- or suffixed letter to the pattern number as being adequate for indicating the type of metal to be used.

Not all colours are equally satisfactory for use with patterns, orange, according to French experience, being particularly liable to lose its colour. Generally speaking, the varnishes examined by Mr. Godel did not show up too well, though it must be admitted that the tests imposed were of a particularly drastic character. The author's advice on the practical side carries with it the hall-mark of wide practical experience, and his test results do emphasise the necessity for applying three coats of varnish if true impermeability is to be guaranteed.

Ladle Additions

Whether ladle additions enter the category of a controlled and desirable addition was the subject of a good deal of discussion at the Bradford Conference. Mr. Blakiston, the author of the Paper under discussion, was against such a practice unless it be with the definite object in view of inoculation. He received a certain amount of support, but it was obvious that the general body of the members present were interested in view of the support lent to the proposition by such experienced foundrymen as Mr. F. J. Cook, Mr. A. Harley and Mr. D. Sharpe. Mr. Blakiston's main objection was based on non-assimilation of the added steel strip or burnings resulting in what he called a "plum pudding" effect. In general metallurgy, the violent alteration of equilibrium has the immediate result of a high rate of gas ebullition, and a cold steel bar inserted in a bath of liquid steel will cause such an effect. When a melter desires to draw a spoon sample from an open-hearth furnace, he first warms the bowl usually by filling with slag and emptying it. This is to avoid boiling from the cold steel tool. If the addition of thin steel strip or ribbon turnings causes a degasification that would in the opinion of many experts be a bull point. Then there is the disadvantage of the cooling effect of the ladle additions, but these can be neutralised by having both the ladle and the metal particularly hot. If the turnings or strip be heated too much, the degasification effect will be avoided. There remains the final point of the possible effect on the graphite by an inoculation reaction, and this immediately revives the question as to whether or not it is commendable, where the required physical properties of the casting render it worth while, to mix two types of iron in the liquid state in the pouring ladle. Mr. Judson in a Paper he read at an annual conference some two years ago showed this to be worth while in the case of pressure resisting castings, and we are aware that such a practice was in vogue in an East Anglian foundry, with excellent results for a considerable period. In these enlightened days, it should be possible experimentally to evaluate the effect of controlled ladle additions. If, as seems probable, it is widely practised, then it should either be condemned or supported, and put on a proper basis by the publication of a series of intelligently conducted experiments.

C

Industrial Development in Special Areas

Up to the end of June, 1938, offers of contributions towards rent, rates and income tax had been made to 59 industrial undertakings to induce them to set up factories in the Special Areas of England and Wales, and further negotiations were in progress.

Durham and Tyneside.—On the Team Valley Trading Estate, near Gateshead, 59 factories had been completed up to the end of June, 57 being occupied and employing about 1,100 people. Tenants had been obtained for 44 further factories, of which 38 were under construction. Other negotiations were in progress. The number of men employed on development and construction work on the Estate and on other industrial sites at Pallion, near Sunderland, St. Helen, Auckland, in South-West Durham, and Tynemouth was 1,571. The Pallion site, at which one factory had been completed, was formally opened by the Commissioner during the month.

South Wales.—On the South Wales Trading Estate at Treforest, 19 factories were occupied at the end of June, giving employment to 419 people. A further 21 factories were under construction for tenants and negotiations for other tenancies were in progress. The factory at Llantarnam was ready to begin production, and building operations continued on the factories at Cwmbran, Cyfarthfa, and Ynyswen. An important firm of glass manufacturers had nearly completed a factory near Pontypool. A matter of 570 men were in employment on development and construction work on the Trading Estate and 407 on the other industrial sites.

West Cumberland.—Two factories were being built at Maryport, for one of which a tenant had been obtained. Good progress was made during the month with a factory at Millom for a leather manufacturing company and with the reconstruction of Cleator Mill, for which two tenants have been secured. Arrangements have been made for the establishment of another new factory near Whitehaven. The West Cumberland Industrial Development Company had, on June 30, 222 men in employment on development and construction work on these sites. Progress has been made with the preliminary arrangements for the repairs to Maryport Harbour.

Grants to Local Authorities

During the month of June, the Commissioner promised grants towards the cost (estimated at approximately £195,000) of public health and sanitary services in the Special Areas. With two exceptions, one of which related to works of public street improvement and the other to the provision of fire hydrants, the schemes were for the improvement of sewerage, water and sanitary arrangements and the provision of an isolation hospital and of a maternity and child welfare centre.

Commitments

The Commissioner's total commitments at the end of June, 1938, in respect of all the Special Areas in England and Wales, were approximately £16,223,000. The total expenditure involved, excluding the capital brought into the areas by new firms being established on the Trading Estates and elsewhere, was more than £22,000,000.

Marburg Lecture

The Thirteenth Edgar Marburg Lecture on "The Torsion Test," by Dr. Albert Sauveur, attracted a large audience. In the lecture, he described a specially built torsion machine, and stressed the utility of the torsion test. He pointed out that it yields valuable data which in general the tension tests do not provide. Certain points which seemed significant were Dr. Sauveur's emphasis on the simplicity of torsion machines and the ease of making the test; also the significance of hysteresis resulting from reverse twisting. Definite evidence in the form of curves showing steps in slip was of general interest.

Book Review

Swedenborg's Treatise on Copper. Mimeographed edition, in three parts totalling 536 pp. Size of page, 13 in. by 8 in. No illustrations. Published by the British Non-Ferrous Metals Research Association at Regnart Buildings, Euston Street, London, N.W.1. Price 25s. per set, plus postage (1s. in Great Britain, 3s. abroad).

In 1734, Swedenborg published the three volumes of his Latin treatise, *Opera Philosophica et Mineralia*, the third volume of which deals with copper and is generally known by the abbreviated title "De Cupro." Hitherto no English translation has been available. In 1901 the late Mr. A. H. Searle prepared a translation which for various reasons was not published, the manuscript being deposited in the strong room of the Swedenborg Society. Here it remained, quite unknown to the public, for over 30 years. In 1933 a member of the staff of the British Non-Ferrous Metals Research Association, while checking certain references to the metallurgical work of Swedenborg, discovered the existence of this translation, and the Association, by kind permission of the Swedenborg Society, undertook to issue it in a form available to the public. The present edition is in mimeographed form: the book no doubt deserves to be suitably printed, but the resources which the Association could spare for the purpose are necessarily limited, and from considerations of economy and other reasons, the present form of reproduction was adopted. The purpose of the reproduction is to make this translation readily accessible to the world at a reasonable figure. In order to keep the price as low as possible, the illustrations have not been reproduced, but if a sufficient demand arises the possibility of preparing sets of illustrations will be explored.

Swedenborg divided his treatise into three parts. The first, which forms the great bulk of the work, deals with the methods of smelting copper from its ores and the refining of copper as practised in Sweden, Norway, Russia, England, Spain, Hungary, Germany, Austria and elsewhere, with notes on the same subject from treatises by various authors. After giving an account of the methods used for the separation of silver from copper, the author then proceeds to a discussion of brass and processes for its production, again adopting the geographical form of arrangement. He then passes to a survey of various methods of casting metals, *i.e.*, statues, bells, cannon, type for printing, shot, etc.

The second part commences with an account of the nature of various copper ores and their occurrence throughout the world, and then deals with the assaying of copper ore, including assaying for silver. The third and last part touches on miscellaneous matters, including the production of various compounds of copper; the specific gravity of copper, its increase of weight on oxidation, dissolution by various acids, etc.

The present edition includes a foreword giving the history of the manuscript translation, and a biographical note on the translator, Arthur Hodson Searle. Indices of names, places and subjects are provided.

(*Continued from next column.*)

The last story is a grim warning to all on holiday at the moment. A man, called up for jury service, asked to be excused, stating that they were so busy at the works that he couldn't afford not to be there.

"So you are one of those people who think that they are indispensable, are you?"

"No, Sir, on the contrary. I know perfectly well that they can do without me, but I don't want them to find out."

"Excused," replied the judge.

And the moral of that is: Don't take more than a three months' cruise, or you may find your services not required when you return.

"MARKSMAN."

Random Shots

Most people will be on holiday during the next few days, and some, no doubt, so accustomed are they to "talking shop," will find it difficult suddenly to detach themselves from business and give themselves over entirely to recreation of body and mind. How better can "Marksman" help these much-to-be-pitied souls than by telling them a few stories? Tales with morals, and food for thought, to lessen the strain of so sudden a change from business to pleasure! The lucky man who can, at a moment's notice, shake off the effects of a year at work, and can enjoy a holiday from the very first glimpse of the sea with light heart and nimble body, let him miss out the moral and tell these stories when the family is gathered around the holiday dinner table. No story that is not fit for little Tommy to hear ever appears in this column. The Editor sees to that!

The first Tale with a Moral is taken from Wyndham Lewis's "Straw and Other Conceits," and is specially selected for the man to whom a few spare moments in which to think for himself is likely to prove fatal.

* * *

"An Ox, a Bee, an Elephant, an Ant, a Dog, a Crane, and a Wombat were assembled one Day in the Woods, giving Tongue in Turn to Any Amount of Practical Wisdom and Improving Conversation. Seeing an Old Man Approaching the Animals Determined to elect him Judge of their Efforts. After Some Hours of Hard Mental Concentration they Demanded the Name of the Winner, only to Find, to their Extreme Chagrin, that the Old Man was as Deaf as a Newt and Had not Heard a Single Word. They thereupon Set on the Aged Person and Bit him so Severely that his Boots were Full of Blood."

And the moral of that is: It is No Use Putting Over a Good Line until you are Sure of your Market.

* * *

A works manager met a foundryman at the Eton and Harrow Match at Lords.

"Hello," said he, "I didn't know you went to Eton, nor yet to Harrow!" "As for that," came the apt rejoinder, "Didn't I see you at the Gentlemen *v.* Players' Match last week?"

And the moral of that is: If you do suffer from a sense of superiority, confine it to business hours when the other fellow cannot answer back.

* * *

A lawyer, who had just lost a case which he had considered as a certain victory, stood in front of the Statue of Liberty in Paris and read out the inscription with bitterness in his voice. "Liberté: point! egalité: point!! fraternité: point!!! C'est la vie, hélas!"

And the moral of that is: 'Tis the little things that count, even full stops, and if you don't come to a full stop at that next traffic light, you will get into trouble.

* * *

A new Bank Manager, on scrutinising the books, found one client with an overdraft of £40,000 without any securities whatsoever. Intending to find the reason for this grave error of his predecessor, he called on his client.

"You must have a tidy little business at the back of you, Mr. Blank," said the manager, "for the bank to have allowed you such a considerable overdraft. What line are you in?"

"I make soup, and can it," replied he of the overdraft. "By the way, do you know anything about the soup business?"

"No, nothing at all."

"Ah well, never mind, you soon will," consoled the business man.

And the moral of that story is: Take life easily. Don't worry. Even if you take infinite pains to do nothing wrong yourself, the other fellow's mistakes will land you in the soup just the same.

(*Continued in previous column.*)

Manufacture of Diesel Engine Cylinders

The methods of making diesel engine cylinders which are practised at the works of the Fonderies Werts at Pantin (France) are described in a recent issue of "La Fonte." The weight of the unmachined cylinders is 550 lbs. Moulding is carried out on the flat, and casting on end.

Fig. 1 shows the mould opened. The mould on the left already has its port core and its water-circulation half-core set. On the right is shown the port core and down gate for bottom castings. The clay thickness pieces are set around the water-circulation core and in the thickness of this core. They are not visible in the illustration. The mould is rammed up in ordinary dry sand and carries false gudgeons to help the precision of marking. In Fig. 3 is shown the assembly of the water-circulation cores. These cores are made from silica sand bonded with a mixture of linseed oil and a proprietary core oil. They are given a coating. The start of the core assembly is shown in Fig. 4. The port core is shown set and the chaplets for supporting the circulation half core, the bottom ingate and the closed riser are clearly seen.

Fig. 5 shows the setting of the circulation half-core. It is kept in position by the holes and by chaplets. The setting of the barrel core is shown in Fig. 6. This core is swept up in loam.

Fig. 7 shows the setting of the second circulation half-core, and the second layout of the port coring. The mould is then gauged, closed, clamped and set upright. It is placed in a pit for casting, which is effected by a side opening carried in the runner cup. An electric furnace refined iron is used for casting the cylinders.

Fig. 2 illustrates the fettled castings. It should be noted that the castings are submitted before machine-finishing to a stabilisation heat-treatment to free them from internal stresses. The mechanical properties of the castings include a Brinell hardness of 230 to 240 and a shear strength of 32 kg. per sq. mm.

This method of manufacture has eliminated all scrap caused by poor quality of metal or inadequate strength. Scrap from other causes is negligible. The main difficulties with this casting are associated with the differences of sectional thicknesses. On the unmachined casting the thickness of the outside walls of the water-jacket is 0.4 in., and the inside wall of the cylinder is 1.2 in. thick.

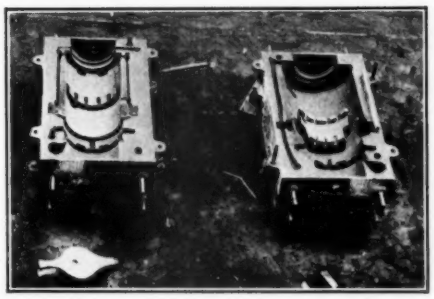

FIG. 1.—MOULD FOR DIESEL ENGINE CYLINDER OPENED.

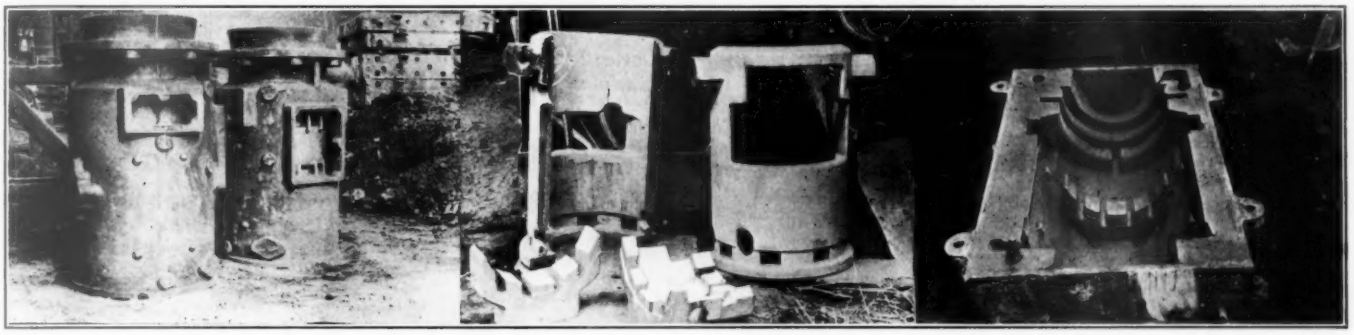

FIG. 2.—THE APPEARANCE OF THE FETTLED CASTINGS.

FIG. 3.—ASSEMBLY OF WATER-CIRCULATION CORES.

FIG. 4.—THE BEGINNING OF THE CORE ASSEMBLY.

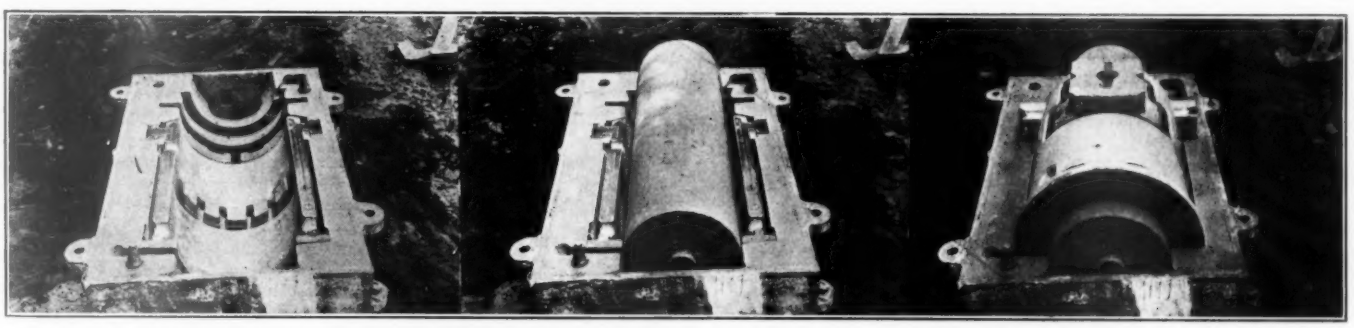

FIG. 5.—SETTING THE WATER-CIRCULATION HALF-CORE.

FIG. 6.—SETTING THE BARREL CORE.

FIG. 7.—SETTING THE SECOND WATER-CIRCULATION HALF-CORE.

Manipulation of Molten Cast Iron

According to "Stahl und Eisen," A. ULITOWSKIJ, in "Stal," describes new processes of fabricating cast iron, particularly the manufacture of small, thin-walled articles with a wall thickness hitherto common in non-ferrous die castings, and also of thin cast-iron sheets. To make the thin-walled articles, the cast iron is melted in a high-frequency furnace and poured directly into a die under the furnace; the top die is immediately lowered into the bottom die by a lever, but is raised again almost at once and the "pressed casting" thrown out of the mould. Only the surface of the casting is solidified by the rapid quenching action, the interior still being molten; if castings have been removed from the press too quickly liquid drops sweat through the solidified surface. Owing to the short period of contact the thermal effect on the grey-iron dies, which are made by the same process, is so small that each die can be used for making a large number of articles. A press, more of an experimental construction, has produced up to 1,400 articles of about 5 kg. in weight per shift, these products being of a satisfactory mechanical stability and accurately dimensioned. For two years 50,000 to 100,000 units have been made each month.

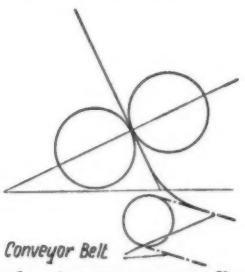

FIG. 1.—ARRANGEMENT OF ROLLS.

A method has also been evolved for making long strips of thin cast-iron plates, the molten metal being poured from a funnel between two rolls arranged with the plane of rolling inclined to the vertical, as shown in Fig. 1. The amount of metal run in and the rolling speed are so adjusted that the strip leaving the rolls is not solid throughout, but similar to the die castings, solid on the surface and still liquid in the interior. The low strength of the strip on leaving the rolls due to the thin layer of solid surface necessitates the inclination of the rolls, which has been so chosen that the strain on the strip on leaving the rolls is a minimum. The strip is also caught up by a belt conveyor so arranged that the strip suffers the least bending. The surface of the strip depends on the roll surfaces, and if clean and polished rolls are used, a strip with a uniform and clean surface can be produced. The careful matching of the casting and rolling speeds, as well as the position of the plane of rolling is of paramount importance.

South African Foundry Activities

MR. NIMMO DEWAR'S ADDRESS

The first Annual General Meeting of the South African Branch of the Institute of British Foundrymen was held on June 30. The meeting took the form of a dinner, very well attended, at the Grand National Hotel, Johannesburg. Mr. T. Nimmo Dewar, the retiring President, was in the chair.

Mr. A. H. Guy, who was elected Branch-President, is the managing director of Eclipse Tube Mill Liners (Pty.), Limited, and is closely concerned in two other engineering establishments on the Rand.

MR. T. NIMMO DEWAR delivered his Valedictory Address, in the course of which he said:—I can assure you that I shall always be proud of the fact that I had the distinction of being the first President of the South African Branch of the Institute of British Foundrymen. The success which has attended the first year of our existence is surely sufficient testimony to the fact that the formation of a local branch of the Parent Institute was long overdue, and I would like at the outset to pay tribute to those who conceived and made possible the formation of this branch. While not wishing to particularise, I would make special mention of Mr. A. H. Moore, who has been the honorary corresponding member for South Africa for some time, and of Mr. A. H. Guy, who did good spade work on his visit to Britain in 1936.

I feel that we can look back on the year which has passed with the utmost satisfaction, and I wish to express my appreciation of the support I have received at all times from the Branch Council. It must be admitted, however, that no Institute or Technical Society can carry on unless it has members who are prepared to come forward willingly and read Papers. Hence I feel our thanks are particularly due to those members who prepared and read Papers during the year under review.

In all enlightened countries, it has now long been realised that the "pooling" of technical knowledge is a far greater and finer thing than for individuals to guard jealously what they consider to be important secrets of manufacture. The greatest and best men have always been those who have been prepared to give freely the results of their work and researches so that the community as a whole may benefit. A body such as ours now affords local foundrymen the opportunity of meeting and exchanging ideas which can only result in goodwill and general benefit.

During my year of office 12 meetings of the Council were held and seven general meetings, at which the following Papers were read:—

"The Production of Solid Castings," by Mr. A. G. L. Lewis.

"Loam Moulding of 5¾ Ton Pot" and "The Problem of Coring a 15-Foot Roller with a 16-Inch Core," by Colonel W. J. Grose.

"The Steel Foundry," by Mr. J. Tonge.

"Pig-iron in South Africa," by Mr. R. R. V. Walton.

"The Use of Plywood in Patternmaking," by Colonel W. J. Grose.

"White Cast Iron," by Mr. P. L. Ward.

The average attendance per meeting was 29.

The membership of the Branch at date is as follows:—

Subscribing firms	10
Ordinary members	37
Associate members	18
Associates	5
Total	70

I consider that the above figures reveal that a successful start has been made, but I would emphasise that for the wellbeing of your Institute, a steady inflow of new members is essential, and I would suggest that all members should make an effort to bring to meetings anyone interested in the science and art of foundry practice, with the hope that our membership list may be increased.

In my inaugural address I traced briefly the history of the foundry trade in this country, and I am pleased to say that as I now vacate this chair the industry is more entrenched than ever as an integral part of the fabric of industrial South Africa. At the moment the iron and steel industry of the world is suffering from what is euphuistically referred to as a recession in trade. In other words, it is passing through a minor depression, which, we hope, will only be of a temporary nature.

In so far as South Africa is concerned, we feel that, although world conditions must inevitably have local repercussions, the gold mining industry has so much at stake that the demand here must remain at reasonable levels.

Business Outlook

We in the foundry business are particularly fortunate that a large proportion of our products are of a semi-durable nature, or to put it another way, the replacement demand for many types of castings is high. Statistics show that when a depression is experienced in the iron and steel industry, the effect is most severe on durable and capital goods such as heavy structural sections, etc., but goods which are necessary to carry on normal production work are not affected nearly so badly. Many types of castings, *e.g.*, crusher jaws, tube mill liners, battery spares, etc., are essential for the ordinary progress of mining, so it would appear that the demand in respect of those products is not likely to drop in an area where the mines are continually breaking fresh records in regard to tonnage crushed. I submit, therefore, that we, in the foundry business, can look forward with a reasonable amount of confidence to a fairly stable market.

I must, however, in fairness, point out when dealing with this subject of markets, that the extent of the market is not limitless, and in this regard I would sound a note of warning. The indiscriminate increase of foundry capacity without due consideration being given to the propensity of the community to consume must be avoided. At the moment, we on the Witwatersrand, are very close to saturation point in so far as foundry capacity is concerned, and the advent of more foundries must inevitably result in a decreased yield on the capital invested in the existing plant. It is only one step from this to a price war, which is harmful to all and generally results in the weaker firms going to the wall.

While discussing the question of prices, I would like to touch briefly on the vexed subject of foundry costing. As a purchaser of castings, I have sometimes been astounded at the divergence of price which I have been quoted for a particular job. Assuming that all prices are given in good faith, the only conclusion that one can come to is that many foundries have not got the faintest idea of how to assess the value of their products, or, alternatively, that no proper method of foundry costing exists.

Need for Costing System

In the course of his Presidential Address last year to the Institute of British Foundrymen, Mr. Bigg asked the following pertinent question:

"Has the foundry industry in general the knowledge necessary to assess the value of its products?"

Mr. Bigg continued to say that he did not hesitate to reply in the negative, and he was equally emphatic in stating that to this particular weakness in our industry's structure could be attributed many of the disabilities which we, as foundrymen, consider to be our portion. He felt that the subject of costing should receive the very close attention of the Institute. He believed that many foundrymen thought that costing was a job solely for the accountant and something quite outside the scope of the industry proper. He, however, felt that costing was an integral part of the industry just as much as the laboratory was, and that there was no more important adjunct to organised management than a good costing system. He continued to say that the costing system, to be efficient, should be simple and capable of interpretation by men who were not accountants, and this could only be achieved by co-operation and understanding between the foundry executives and the cost accountant. He mentioned that costing was not an abstruse subject, and its main constituents should be logical reasoning and simple arithmetic. I can only heartily endorse the sentiments expressed by Mr. Bigg, and I feel that a sub-committee on costing, sponsored by this Branch, would go a long way towards removing some of the anomalous quotations which are received and which, in many instances, make us the laughing stock of purchasers.

In looking to the future, we can only be reasonably confident that our country will develop industrially and offer more scope for foundry practice. With improving technique, local foundries are to-day able to turn out material which in the past had to be imported, and as time goes on there is no doubt that we will become more and more self-contained.

The iron foundries, which had an output of something like 24,000 tons last year, are particularly fortunate in having little or no trouble in regard to the supply of raw material. Blast furnaces at Iscor and Newcastle are to-day capable of meeting all local requirements, and it is interesting to note that during the year 1937 just over 20,000 tons of locally-produced pig-iron were used in South African foundries. The steel foundries, with a selling output of, say, 12,000 tons last year, have, perhaps, not been quite so fortunate in regard to a steady supply of good quality steel scrap, but due to a co-operative effort on the part of the industry, a steel scrap famine has, to a large extent, been avoided. I feel that the shortage of steel scrap is only a temporary phase, since the natural tendency of the heavy steel industry must be towards the use of molten pig-iron in the steel melting furnaces, and in due course this should release sufficient scrap to meet the needs of all foundries.

It now only remains for me to hand over the cares of office to our old friend, Mr. A. H. Guy. Mr. Guy needs no introduction to any of the gentlemen present. He has long been a well-known figure in the South African foundry business, and I sincerely hope that during Mr. Guy's year of office the Branch will achieve success which will "Eclipse" the progress attending our efforts during the past year.

Holidays with Pay

As the result of negotiations between the Triplex Foundry, Limited, Great Bridge, Tipton, and the Ironfounding Workers' Association, there is a likelihood that considerably more West Midlands foundry workers are to have holidays with pay. Alderman H. Sinclair, of Warrington, national organiser of the Ironfounding Workers' Association, who has conducted the negotiations on behalf of the men in this case, has communicated with other Midland firms engaged in the trade, and if they fall into line, he says it will mean that between 15,000 and 20,000 workers in the trade in South Staffordshire will have holidays with pay.

THE PLATING SHOP of the machinery department of Edgar Allen & Company, Limited, Sheffield, has been extended. An additional three-roll plate bender has been installed.

Pattern Colours and Varnishes*

By GEORGE GODEL

Usually patternshops either use a home-made varnish or one bought outside with the condition that it is to be "non-sticky," but beyond the general question of cost not much interest is taken in what is really a worth while study.

The wood from which patterns are made is by its nature hygroscopic when air-dried, that is to say, when it still contains a matter of 15 to 18 per cent. moisture, the wood is deemed to be dry and satisfactory. It still has the property of taking up moisture from the surrounding atmosphere or from materials with which it makes contact. If air-dried wood absorbs moisture and produces an overall swelling, a swelling which varies in intensity in relation to the position from which the wood has been cut and also according to the method used for the sawing of the original log. Conversely, wood containing moisture decreases in volume after drying, in the inverse ratio to the swelling.

Thus an unvarnished pattern if used in the foundry will absorb moisture from the sand during moulding, and will swell, and will result in a larger casting than was called for. If the pattern remains in the sand for any length of time it will be difficult to strip and even cause the disintegration of the mould walls.

To prevent such occurrences it is essential to use a waterproof coating which will not stick to the sand and which must be as thin as possible. Varnishes are all designed to fulfil these conditions, but it is essential that besides being waterproof they are wear-resistant. Varnish carries the advantage of bestowing a good appearance to the pattern, without resorting to "quality" wood, by giving it a predetermined colour.

Varnishing patterns, outside of considerations of moisture and drying, should fulfil the following conditions in order to ensure the conservation of dimensional accuracy: (1) Help the patterns to strip smoothly from the mould; (2) indicate by colour the various parts, such as the body of the casting or the core prints; (3) show up which surfaces of the casting are to be machined, those parts which are not part and parcel of the casting and those parts which have to be stopped off, and (4) indicate by a special colour the type of metal to be cast into the mould—a matter now under consideration by the [French] Standardisation of Patterns Committee.

The paints or varnishes used on patterns ought not to be so thick to augment the dimensions of the pattern; must be waterproof, and therefore not subject to age-cracking; must not be sticky, and finally must yield a surface to which sand will not adhere.

Choice of Coatings

These considerations have induced a fair amount of research work on paints, various varnishes capable of being used for pattern work. Caution is necessary in their use. Paints based on oil do not dry very quickly, do not yield a uniform surface, and have a tendency to pick up sand. They can, however, be used for the exterior of core boxes or for the inside of patterns in places where no contact is made with the sand, but care must be used to exclude it from the joints of different parts of the pattern.

There remains to be considered thick varnish, synthetic varnish, spirit varnish and lacquer, spirit varnish with pigments known in commerce as "enamels," and "cellulose paints."

The thick varnish can be ruled out because of its slow drying properties and affinity for grains of sand, and also the synthetic varnishes which are sticky. Thus there remain the lacquer varnish, enamels and cellulose paints. In order to test the various varnishes, the author made contact with various manufacturers of high standing. Samples were received, and on these the following tests were made:—(1) Measurement of the thickness of the varnish film; (2) a permeability test; (3) artificial ageing test; (4) wear resisting test, and (5) tests for adherence to sand and the elasticity of the varnish.

Pattern Shape Conservation

According to work on varnishes carried out by the Technical Services attached to the [French] Air Ministry, it is possible to state that certain varnishes can sufficiently waterproof a piece of wood and insulate it from external moisture, but the moisture contained in the wood at the moment of varnishing can slowly evaporate through the surrounding varnish film. Because of this the dimensions of the piece can change.

This fact introduces a side issue, and suggests the advice to owners of patternshops to control the moisture of the timber used to a figure lower than 15 to 16 per cent. by weight. Wood placed in contact with the normal atmosphere absorbs water. Though it may appear to be dry at the time of using, yet during the making of the pattern the patternmakers may notice dimensional differences. These may be easily rectifiable, but sometimes they cause rejection. Consequently an increase in the cost price may result.

It is desirable that patternshops should have a drier at their disposal. Obviously, it will be protested that driers cost much money. Whilst agreeing with this, it should be pointed out that this refers to the old-fashioned systems having high cubic contents. Nowadays there are available quite small, cheap stoves, allowing really small quantities to be dealt with. One type of drier—the "Micro-séchoir" uses the same source of heat as the glue-pots and hot plate, and thus the cost is at a minimum, since it merely reflects upon prime costs.

As a cause of deformation, of reduction in the size of patterns during making, it should be added that there is another factor inherent to the installation of the shop. Patternshops are large in relationship to the number of workmen employed, because they should be equipped with machines placed handily for the patternmakers, so as to avoid too much running about. To avoid loss of time through waiting, several machines of the same type should be installed and erected at suitable spots, that is, near to the working benches.

A suction system for the removal of sawdust will draw air into the shop in quantities varying from 100,000 to 250,000 cub. ft. of air per hour, according to the number of machines served by the system. This air should be replaced by the outside atmosphere, and forgetting the difficulties of the heating of the shop, it is easy to imagine that the atmosphere is often humid.

Under these conditions, the state of the dryness of the wood is constantly changing, and the dimensional accuracy of the patterns suffers therefrom. It often happens that warping and dimensional changes for which the patternmaker cannot be held to be responsible occur. In order to ameliorate these conditions, it is necessary to connect the suction system with the heating system. These controlled heating and suction systems do exist. The air brought by the sawdust removal system is reconditioned by an aspirator which acts upon the filter bags placed below the receiver. The cleaned air passes along ducts heated by coils and is delivered back to the shop warm in winter or fresh in summer. In the latter case, the heating coils are not used.

Varnish serving the purpose of conserving the shape and dimensions of patterns must be kept in a room having the same temperature as the shop where the pattern has been made.

Varnishing Patterns

The film of varnish must be supple and follow the shrinkage or swelling of the wood it is to cover—and such movements must not be impeded. According to the pamphlets issued by the [French] Air Ministry, "permeable varnish should, by the superimposition of two coats, yield a waterproof film. An impermeable varnish can yield a permeable film if the film be too thin, or where it is unevenly applied. Brush painting is more impermeable than either dipping or spraying. Hence the importance of the method of varnishing.

For the varnishing of patterns two distinct methods are used:—(1) Brush painting (the more usual), and (2) spray painting with the air gun.

Brush Painting.—This should be carried out in a dust-free shop heated to about 68 deg. F. Varnishing should be preceded by an essential operation—stopping or filling. For pattern usage, this operation, when working with spirit varnish, is generally effected with a natural lacquer diluted with varnish spirit (95 per cent. methyl alcohol), consists in stopping up all holes, cracks and screw heads being previously stopped up with either wax or Plastic wood. The brush applied lacquer varnish, when used as a filler coating, ought to be—after an hour or so—pumice-stoned, which evens up the surface to be varnished. Any pores, protruberances, unevennesses and knots having been levelled up, it is necessary to clean the pumice-stoned surfaces with a fluffless duster.

After having given the first coat of lacquer varnish or "enamel," the work should be allowed to dry for about four hours, before applying the second coat. If a third coat be deemed necessary, the same process should be followed. (Any coat given as filler should not be considered as a coating.)

It is essential to allow four hours between each application of varnish, for the apparent face of the varnish can appear to be dry, but underneath it may not be so. For the hardening of varnish to be complete, 24 hours are necessary if adherence to sand is to be definitely excluded, and no patterns should enter the foundry before the elapse of this period.

Spray Painting

When using spirit varnish or "enamel," the temperature should be 68 deg. Fah., and the room where it is done should conform in every way to the Home Office regulations, and fire-resisting materials should be used in its construction. It should also be well ventilated and an inhibition to smoking imposed. As with brush application, it is necessary to give a filler coating (in this case a special filler is called for, which is suited to the varnish used—cellulose type for cellulose painting, and so on), and rub down with pumice. After thorough dusting, using the compressed air available with the spray gun, spray on a coat, allowing an hour before giving a second coat, and similarly for a third coat if such be thought necessary. Allow the varnish to harden for 48 hours before putting it into commission. Though manufacturers quote nine hours as being adequate, experienced sprayers insist on much more.

Testing Methods Used

Wood Used.—Lime 350 × 100 × 20 mm., for plaques to be used for wear testing, sand adherence and elasticity, the balance kept as records.

Permeability.—Spheres 40 mm. dia. machined from lime were used.

Artificial Ageing.—Spheres 35 mm. dia. machined from lime.

Lime was chosen because of its property of readily absorbing moisture.

* An abridged translation. A Paper presented to the Lyons Conference of the Association Technique de Fonderie.

Permeability Tests*

The 40-mm. dia. spheres of lime were identical with those used by the Air Ministry for its tests (except the test-piece which was of beech). On each was fixed a 4× 50 mm. screw to a depth of 35 mm. and on to this was fastened a steel sheet label giving the necessary identification. Each ball was brush-varnished after a filler coat of lacquer with one, two or three coats, and allowing an interval of 4 hrs. between each application. Though the Air Ministry wets the balls by immersion, the author prefers brush wetting—a method used for plaques and a more practical one. Spheres are used in preference to prisms, because they carry no corners, and therefore the thickness of the coats are more even than is the case where edges exist. The spheres, having been weighed, are immersed in water at a temperature of 65 deg. ± 4 deg. The centre of each ball is kept constantly in the water at a distance equal to 5 cm. ± 1 cm. The duration of this immersion was 48 hrs. On removal, each sphere was rapidly dried with filter paper and then weighed. The permeability (percentage of water absorbed) is the weight after testing minus the initial weight divided by the initial weight and multiplied by a hundred. It is interesting to note that the [French] Air Ministry specifies for varnishes required for "surfaces subjected to rubbing and the direct action of external agents" a permeability figure less than 0.6 per cent., derived under the conditions set out above.

According to Mr. Marcel Monnin, an official attached to the [French] Air Ministry, "All varnished assemblies should not absorb moisture to an extent of more than 3 per cent. of its weight, after 48 hrs. immersion in water. It should be noted that these immersion tests are crude, but they do constitute a rapid means of ascertaining impermeability in spite of the fact that the assembly may not be destined to be used in water."

Without being so insistent as the [French] Air Ministry, which specifies 0.6 for a wetted sphere, nor so lenient as Mr. Monnin, who only requires 3 per cent. for assemblies, the author believes that from such a test the permeability requirements for patterns should be the average, say less than 1.8 per cent.

Artificial Ageing

For this test, spheres made of lime were again used, but they were of 35 mm. dia. They were coated as in the previous test, then weighed and placed upon a wire framework resting on a water bath. These containers, covered by a glass plate, were then placed in a non-air-circulating stove for eight days. The temperature of the stove was controlled at 95 deg. Fah. ± 5 deg.

The coefficient of ageing was calculated as before:—$C^o = \frac{W_s - W_1}{W_1} \times 100$. The spheres were then weighed and compared with standard plaques. They were examined beneath a magnifying glass to reveal the presence of cracks. To complete the test, the spheres were subjected by water immersion for 48 hours to the same permeability test, and the results were compared with those of the above-mentioned tests.

Coat Thickness Tests

Lime plaques, 350 × 100 × 20 mm., were varnished with one, two or three coats after "filling," there being an interval of 4 hours between each application. The hardening period was 48 hours. The measurement of the thickness was effected at four selected positions before and after the hardening of the varnish. The average of the four tests was taken as the mean figure for each plaque. It should be noted that for spray painting the figures were taken on plaques not subjected to a "filler" coat.

From each plaque, a sample 10 cm. long was taken for a wear test. On plaques carrying three coats, a second sample 65 mm. long was taken for carrying out sand adherence and film elasticity tests.

Wear Tests*

Three small plaques, 2 cm. × 2 cm., taken from the 10 cm. long test-pieces referred to above, were submitted to the action of a sand blast delivered under standardised conditions. This delivers sand from a height of 5 cm. under a pressure of a 100 grms. per sq. cm. The sand is powdered and sieved so that it passes through a No. 50 sieve, and is completely retained on a No. 200 sieve. The playing of the sand blast is continued until all the varnish disappears and the wood background is in evidence. The time taken to effect this is noted on the three samples and averaged for recording.

Sand Adherence and Film Elasticity†

Samples, 65 mm. long, of each of the plaques carrying three coats of varnish were rammed in a vertical position into a clay-silica sand, and allowed to remain there for 48 hours. Each sample varnished on one face could therefore absorb moisture from the sand both from its varnished and unvarnished sides. A length of 1 cm. projected from the sand for the purpose of comparing the colour and brilliance.

The moisture content of the sands was established by weighing and stove drying. It was controlled at 8.5 per cent., a percentage considerably higher than the normal, which varies from 4 to 6 per cent. The absorbant wood increases in volume, which allows of the evaluation of the varnish on the face in respect to its elasticity, and its potentialities for resisting this increase, without cracking or crazing.

Varnishes Tested

Only two commercial houses, both having a good reputation, were approached for the supply of samples. Four categories of varnish were submitted to the tests:—(1) Spirit (lacquer) varnishes, including (*a*) natural lacquer made up by the patternmaker, (*b*) a similar product bought in the open market, (*c*) spirit varnishes containing plasticisers for giving smoothness and colour powders for bestowing certain shades; (2) spirit "enamels" in various colours; (3) cellulose paints in various colours, and (4) black japan. This last is a mixture of bitumen powder and terebine (esprit de thérébentine éthéré), often of an alcoholic base; a small quantity of manilla gum; resin, and an aniline colouring mixture. It is used by a fair number of patternmakers, who should know more about it. After detailing the methods of labelling the samples and the application of the varnishes to the patterns, the results are set out in tabular form. The author has then drawn the following conclusions.

Conclusions

After numerous tests (11 to 16 on each of them), which it should be unnecessary to point out were of a particularly severe nature, it is now possible to enunciate the following:—

(1) Varnish with 25 per cent. of natural lacquer, made up in the shop, resists wear reasonably well, but is too permeable and is not recommended.

(2) Varnish with 25 per cent. natural lacquer bought in, according to the sample submitted, can be used with a minimum of three coats, not including the primary or "filler" coat.

(3) The coloured lacquer varnishes submitted to test were impermeable, but subject to rapid wear.

(4) The enamel paints tested, except blue and black, can be used with two coats, not counting the filler coat. The blue really demands at least three coats. They have a permeability near to or less than 0.6 per cent.

(5) The cellulose paints tested, except the black, are quite useful, and offer high resistance to wear (three coats lasted from 7 to 10 hrs.). However, certain colours, especially orange, require the application of three coats. The application of a coat [by spraying] demands much less time than when brush painting. The artificial ageing tests are submitted with reserve. Practical tests are preferable.

(6) The black varnish does not fulfil the necessary conditions. The [French] Committee for the Standardisation of Patterns in October, 1928, laid down the colours to be used for patterns: yellow, red, grey, black, blue, white and green. They even went so far as to specify natural lacquer as a varnish for the bodies of patterns. The author would suggest that in view of the above results, that the findings of the Committee be revised in respect to colouring, to which subject about one-fifth of their Report is devoted, under the heading "Varnishing and Colouring of Patterns and Core Boxes."

He would like, as a specialist in the subject, to see the number of colours reduced, and the work of colouring patterns by patternmakers so simplified. For example, it does not appear essential that a red bar should be painted on a yellow body pattern to indicate that a portion has to be stopped off. It should suffice if a black dotted line be painted on or the colour indicating a core print be used. Black, which does not give every guarantee against wear, or impermeability should, if it be not replaced by another colour, be applied always on the varnish selected for the body of the pattern.

In order to aid the Standardisation Committee the following suggestions are put forward:—Orange or red for the body of the pattern; grey for core prints and portions to be stopped off; natural lacquer varnish in three coats for the wearing surfaces and for the internal faces of loose pieces. For faces to be machined, blue for steel and iron, yellow for non-ferrous. Black for the exterior of core boxes and grey for their joints.

This restricted number of colours would have the decided advantage of not upsetting established conditions. As to giving an indication of the metal to be used by a square of colour, but little advantage is shown. In a pattern stores, this can be hidden by a neighbouring pattern. To avoid errors it is preferable to use a suitable letter preceding or following the pattern number. This has the advantage of remaining on the pattern for all time, whilst a painted square can easily disappear through wear or fading. When the Committee, in agreement with users, have thus set out the number of colours to apply, the manufacturers of pattern varnishes will have the chance of studying their products so as to make them more impermeable and wear resistant. The author concludes by thanking the numerous organisations and persons who have interested themselves in his researches.

Long Service Records

The Cannon Ironfoundries, Deepfields, Bilston, is a firm which has records of its workmen with long service which is well worth notice. Seven members of one family have worked a total of 300 years with the firm. Starting with the late Joseph Richards, of Bilston, who worked for 50 years, his four sons and two grandsons have added another 250 years. Their services are:—The late Jim Richards, 55 years; Joseph Richards, jun., 60 years (he retired two years ago); Thomas Richards, 58 years; E. Richards, who left after 30 years; and the two grandsons, A. Richards, still there after 30 years, and S. Richards, 18, also still a patternmaker. There is another record which the foundry probably holds, as seven other members of the staff are still working after 50 years' service. For real length of service, however, Mr. E. J. Bryden, the secretary of the company, says the record of a moulder, Benjamin Worton, will probably remain unbeaten. Worton remained at work until over 80 years of age and spent 71 years in the service of the company.

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* Carried out by the Laboratoire de l'Institut National du Bois, Paris.

* Carried out by the Testing Laboratory of the Conservatoire National des Arts et Métiers.

† Tests carried out by the French Foundry Research Institute.

English and American Steel-Foundry Practice Contrasted

Dr. C. J. Dadswell's Paper on the above subject, presented to the Bradford Conference of the Institute of British Foundrymen, and published in the JOURNAL for July 14 and 21, was well received. The discussion ranged from the grain size of the sand to be used for heavy steel castings to the grain size of the steel. Other subjects touched upon were the relative merits of acid and basic electric steel, the conservation of skilled labour, and metal penetration.

Quality of American Steel Castings

MR. C. H. KAIN, opening the discussion, thanked Dr. Dadswell for his Paper, and commented on the fact that, at long last, the author had exploded the idea that American steel castings were very much worse than British. He feared that a number of steel foundries had comfortably advanced that statement on occasions rather to cover bad practice than from a true knowledge of the facts. Undoubtedly, American castings recently had improved very considerably.

Dr. Dadswell had made reference to the drift from the foundry of skilled artisans into better-paid trades, and had suggested that one of the methods of overcoming this difficulty was by better technical control, presumably with the object of using unskilled labour. Mr. Kain suggested that this was rather a top-heavy sort of organisation. Executives ought at the same time to give serious consideration to improving the standard of their labour, and striving to achieve the same conditions which obtained in the better-paid and more secure sheltered trades.

Permeability of Steel Moulding Sands

The Paper naturally dealt very largely with sand and sand technique, because feeding steel castings in America was presumably much the same as here. The author had referred particularly to the high permeability sands commonly used in America, and gave the permeability figure of 200 as being high in a backing sand. The speaker suggested that such a figure was not particularly high for steel moulding sand, for green-sand work, and that a range of 350 to 400 was not uncommon and certainly gave better results with green sand.

The author had also stated that silica flour was occasionally used to prevent penetration of steel into cores, and to strengthen the mixture for use in top parts. Personally, Mr. Kain would consider it better practice to use a finer grain of sand than to use a coarse sand and to mix it with silica flour, as that was frequently a cause of surface scabbing.

Mechanical Sand Grading Preferred

It was interesting to note that there seemed to be general agreement that mechanical grading or mechanical separation of silt was superior to pneumatic methods. These had been tried for many years, and personal experience had shown them to be very erratic. There were a number of mechanical separating systems on the market which work very satisfactorily.

He asked the author what the reason was for the increase in grain size in the reclaimed sand. There seemed to be a greater quantity of sands on the 44/66 mesh sieves, which might, of course, be due to agglomeration or to concentration.

The Paper claimed that the acid furnace was very widely used in America, and he would like to know what scrap they had available for use in such furnaces, for one of the greatest difficulties in this country was to obtain low phosphorus scrap. It was also stated that the acid furnace produced steel at lower cost than basic. Could the author give any indication of the relative cost of the steel made by the two furnaces?

Grain-Size Control

Another statement was that grain-size control in steel castings was not practised in this country, but that was questionable, as he believed it was practised in a number of cases. One or two foundries certainly did it deliberately, and many others did it unconsciously by the addition of aluminium.

Dr. Dadswell had dealt with specifications, and the question was worthy of serious consideration. The time would undoubtedly come when steel founders would have to meet very stringent specifications. He thought the author's suggested method of further grading rather than a general all-round increase of common specifications was greatly to be sought for, but he seriously doubted the statement that the purchaser of these high-tensile steels would "naturally" pay a higher price than for the ordinary steel. Personal experience was that buyers wanted the higher grades at the same price. Dr. Dadswell had also made some suggestions for co-operative or joint research, which has undoubtedly produced very good results in the United States, and he agreed that the steel castings makers in this country might also give that subject very serious consideration.

American Steel Castings

DR. DADSWELL, after thanking Mr. Kain for his remarks, said he was not sure whether he had overstressed the quality and finish of American castings, as he was surprised with what he had seen, particularly in view of the general impression here that American foundries could satisfy customers with rougher products than was possible in this country. A visit lasting two months was insufficient to see every foundry, and only "impressions" could be gained.

As to the movement of skilled labour away from the steel foundry industry, he did not quite mean what Mr. Kain had apparently understood. What he had in mind was that by scientifically controlled production one could get larger outputs from the same number of men; for example, production could be increased by the elimination of waste movement by the workers concerned. In fact, one found that the level of earnings increased when the workers were on piece-work, as one obtained higher output. He had no desire to see the development of means generally to eliminate skilled men, and to employ in their place unskilled men, but rather to employ skilled men to better effect.

Permeability of Steel Moulding Sands

The figure of 300 to 400 for high permeability sand seemed rather high to him. He did not think many foundries used such material on green-sand work. The average permeability of his facing sand was, if he remembered rightly, about 180, and 160 to 180 for backing sand. He believed that in examining permeability figures one must bear in mind the nature of the sand which was being considered, the bonding agents, the amount of moisture, and so forth. The permeability of a synthetic sand might not necessarily be required so high as that of a naturally-bonded sand, which might take a higher moisture content and, therefore, generate more steam and gas.

Silica Flour and Steel Penetration

The question of mixing silica flour into moulding sand in order to increase its strength in top parts to prevent scabbing, it must be admitted, did appear rather odd. He failed to appreciate why a very fine sand should not be used, and he was trying that at the present time. He had tried the addition of silica flour as carried out in America, and found that it did have some beneficial effect. It was particularly useful in preventing penetration of steel into cores where they were surrounded by heavy sections of metal. Until one had seen it, it was difficult to visualise the amount of penetration that could take place into, say, a 6-in. dia. core, surrounded by 5 or 6 in. of steel. One objection to the addition of silica flour was that of cost. He believed that silica flour could be purchased much more cheaply in America than here.

As to the reclamation of sand, the American conclusion that the mechanical method was the most satisfactory and economical confirmed personal opinion after exhaustive tests.

Acid and Basic Steel Problems

He had with him no actual figures of the relative costs of acid and basic steel, but he would supply Mr. Kain with more information on that point later. It was not only the question of the cost of the steel which gave the acid some advantages over basic for certain types of production. For example, the acid furnace was a very rapid melting unit, but it was a little difficult to get accustomed to, and the composition was not so easily controlled as in the basic furnace, particularly for the carbon content of mild steel.

Grain-Size Control

He did not imagine that there were many foundries intentionally carrying out grain-size control. It had happened unintentionally, but he did not think that many of the basic electric foundries were doing it for their castings, because there had been a tendency to keep the aluminium as low as possible. It was usually insisted that one should add as little aluminium as possible to the steel, and the amount which was used in Sheffield varied from practically nothing up to half a pound per ton, which was insufficient to give a controlled grain size. Some interesting work on the effect of aluminium on electric steel had been published by Simms and his co-workers, according to whom the addition of half a pound per ton was the worst amount of aluminium that could be added to steel.

Casting Locomotive Frames

MR. J. H. COOPER said the author had mentioned the casting of a locomotive frame up to a length of about 90 ft. He had seen some very large ones run, and he would like to ask whether the mould was heated before pouring, whether it was run at both ends, how many runners were employed, and finally the method of easing after pouring.

DR. DADSWELL, in reply, said he would not be certain, but he did not believe the moulds were warmed up after closing. The only reason for such a heating would be to dry any jointing materials between cores. The cores were very carefully checked over for size, as not one locomotive frame was made, but perhaps 30 or 40 frames, and therefore the core sizes were carefully controlled, and they were prepared to jigs. The runners depended on the weight of the frames, but they usually took the form of one or more down-gates at the centre of the casting, with longitudinal runners at the bottom, having several ingates. The general principle was to run from the bottom with a longitudinal runner. Unfortunately, he did not see a frame actually being cast.

Large Grain Sands Preferred

MR. E. LONGDEN said that the larger sand grains were more resistant to fritting than the smaller grains, so that a large grained sand with suitable refractory coating should be the aim.

DR. DADSWELL said that, despite very careful painting and the working of the paint into the

(*Continued on page* 64.)

Dust Collectors for Grinders

BY OUR ENGINEERING CORRESPONDENT.

An efficient self-contained heavy-duty dust collector for grinding machines and other equipment when a very large amount of dust is evolved is the "Cyclocell," a production of the Visco Engineering Company, Limited, Croydon (near London), who are specialists on dust removal, more particularly according to the centrifugal, oil film, and bag filtration methods. The new collector is in the form of a vertical, welded-steel cylinder, divided internally and transversely into three compartments, which is placed on the floor, or in any other convenient position adjacent to the grinder. From the hood of the latter a short trunking connects to a small motor-driven suction fan, which discharges all the dust-ladened air to the centre compartment through a tangential inlet. Consequently the air moving with high velocity is given a pronounced cyclonic or spiral path, and most of the very heavy metal dust is thrown to the outside by centrifugal action and falls down a hopper-shaped metal shute into the lower or storage compartment. This has a cleaning-out door easily detached and replaced, and the accumulated dust is removed at convenient intervals.

The air from the central cyclonic compartment moves upwards through deflectors to the upper compartment, which is provided with one or more oil-film filter cells, on the well-known "Visco" air-cleaning principle. These are composed of a circular metal frame, fixed horizontally and loosely in the cylindrical casing, like a tray, having at the top and bottom a close metal mesh with the space between packed with a large number of small metal ferrules. Before use these cells, easily lifted in and out of the casing, are dipped in "Viscinol" (a special oil) and allowed to drain. The ferrules are therefore all coated with a thin oil film representing a very large total area which is brought into intimate contact with the much divided air stream passing upwards. Under these circumstances practically every trace of dust is removed, even with particles below 10 microns in size (1 micron equals one-thousandth part of a millimetre). Consequently, in nearly all cases the air can be discharged from the top of the collector back into the workshop again without any need for trunking leading outside the building.

The best type of collector to use depends upon the amount of dust evolved by the grinders. For very light duty the Visco "G" type self-contained collector consists of a simple baffle chamber which is sufficient to separate most of the dust on the inertia principle, followed by the oil-film cells, to remove all the remainder. For what may be medium or ordinary duty the "CG" collector is available, which has a rectangular casing containing a horizontal cyclone chamber with a series of fixed vanes or small baffles and on the top, as before, an oil-film cell.

FIG. 1.—THE "VISCO" CYCLOCELL TYPE DUST COLLECTOR.

All three designs are on the same basic principle, the difference being that the larger the amount of dust the more effective must be the primary cyclonic separation, so that the secondary oil-film cell has only to deal with the very fine dust and is therefore able to continue in operation for considerable periods before being removed, cleaned by means of hot soda solution, and re-oiled.

English and American Steel-Foundry Practice Contrasted

(*Continued from page* 63.)

face of the core and mould—he was referring to large castings of from 30 to 100 tons weight—examination of the sand after casting under the microscope indicated that metal was mixed with the sand.

MR. LONGDEN said it was possible to get definite fritting of the sand behind the blacking or refractory coat if unsuitable sand were used. Moreover, occasionally there were strains of metal which held in this. The use of silica flour if very fine would be preferable generally to fine-grain sand.

Steel Penetration

MR. T. R. WALKER said he had examined microscopically the specimens to which Mr. Dadswell has referred. Some of the cores were made from core sand with an oil binder, and the steel had penetrated between the sand grains. The grains were not fused together. If the specimens were broken up and analysed it was quite common to find that the steel amounted to 50 per cent. of the total weight, and it was actually steel of approximately the same chemical composition as the casting itself.

Regarding Mr. Kain's query respecting the increase of percentages of some of the sand grains after reclamation, an increase in the proportion of larger grains was only to be expected, since many of the small and very small particles had been removed. For example, if one had a sand mixture containing 80 per cent. of sand grains with 20 per cent. of clay, and all the clay were taken out, the material remaining would naturally contain 100 per cent. of sand grains. Actually, the removal of material in desilting was not so simple as that, as some proportion of the larger grains was removed at the same time as the required amount of silt and clay.

Grain Refinement

MR. R. C. TUCKER thought that when foundrymen were up against the question of permeability it was very much better to use a uniform grain sand, and stop it up with silica flour, which would be taken out by the silt plant, than to use two different grades of sand, one for the top and the other for core and sides of the mould. With regard to the control of grain size of metals by the addition of aluminium, he did not appreciate references to "controlled grain size." The expression "grain refinement" was preferable.

Welding Research

FIRST PROGRESS REPORT

The First Progress Report of the Research Committee of the Institute of Welding, recently issued, states that with regard to high-tensile steels, a comprehensive list, classified in order of their tensile strength, has been drawn up. From this a number of the more important commercial steels useful for structural purposes have been selected and the experience of users and makers as to their weldability is being ascertained.

This part of the work is being carried out by a special panel under the chairmanship of DR. L. REEVE. This Panel will report on the weldability of each of the steels selected and will submit a detailed programme of investigation where this is required. A further list of steels used in pressure vessels is being prepared. The steels are classified according to their chemical composition and physical properties and it is hoped to determine which alloying constituents affect their weldability either favourably or adversely. Lists of steels for other purposes will also be classified so that it will be possible to choose which of the many steels available should be used, given the mechanical properties necessary. It has yet to be considered whether specific welding conditions should be applied to the steels now produced, or whether new specifications for steels which are readily weldable should be drawn up.

Alloy and Stainless Steels

The welding of high-alloy steels is becoming increasingly important and valuable notes have already been contributed on this problem. Meanwhile a memorandum on the research work required on the weldability of intermediate alloy steels has been received and a detailed programme of research is being formulated.

A memorandum on the welding of stainless steels has been submitted and this will be incorporated in the report of the sub-committee in due course. A considerable amount of investigation has already been carried out on stainless steels and it can be said that there is no immediate problem awaiting solution.

Cast Iron

A complete survey of the information available on the welding of cast iron has been prepared by the British Cast Iron Research Association and a detailed programme of the research work which has been shown to be necessary is in course of preparation.

Arc-Welding Procedure

In all processes of welding, the Report states, the need for and the possibility of proper control of the welding technique are coming to be more fully realised and the necessity of ascertaining accurately how far the welder can affect the quality of the weld under pre-determined conditions in all the various welding processes is a work of first importance.

A Panel under the chairmanship of MR. W. T. EVERALL, is carrying out work on fillet welds made in the horizontal and vertical positions in order to determine within what limits of procedure satisfactory welds may be laid down. The effect of the electrode size, current and welding speed on root penetration and satisfactory shape of weld is being studied and several hundred specimens have already been prepared, sectioned and accurately measured. The effect of any lack of penetration at the root of fillet welds on their load-bearing capacity is also an object of investigation. A series of strength tests on fillet welds made with procedures which are known to result in various degrees of lack of penetration is in progress to determine to what extent and within what limits lack of penetration is of significance.

(*Continued at the foot of previous column.*)

(*Continued from the next column.*)

The work of this Panel is being carried out by the Quasi Arc Company, Limited, and by Murex Welding Processes, Limited. Mr. J. Turnbull, of the British Corporation Register of Shipping and Aircraft, is checking all the measurements. The Research Committee has already expressed its appreciation of the work of this Panel and of the generous help given by Mr. Turnbull and the two electrode manufacturers concerned.

The Founding of Nickel-Bronze and Allied Alloys

By FRANK HUDSON

(*Concluded from page 42.*)

II.—ADDITIONS OF NICKEL BETWEEN 5 AND 10 PER CENT.

When the nickel content reaches or exceeds 5 per cent. the foundryman will notice a distinct change in the surface appearance of the molten metal in the crucible. There is a tendency for a darker and slightly heavier oxide film to form. In order to obtain the best results, this must be allowed for in casting production, and it is advisable to employ the use of choke gates as shown in Fig. 2, otherwise there is a possibility of this oxide becoming entrapped in the mould and producing dirty areas on the casting. In cases where only parts of the casting have to be machined, choke gates might be omitted, providing care is taken to ensure that machined faces are cast down, as is shown in certain of the examples given in Fig. 3.

Furthermore, alloys in this group are susceptible to heat-treatment, when improved mechanical properties can be obtained. With suitable practice a gunmetal containing 5 per cent. nickel, 5 per cent. tin and 2 per cent. zinc can be made to give a maximum strength of 37 tons per sq. in. with 16 per cent. elongation on 2 in. and a Brinell hardness of 171. In order to obtain such results it is, however, essential that castings be free from the slightest trace of porosity and interdendritic shrinkage. Whilst a small amount of this defect is not uncommon in the average commercial casting, its presence is fatal to alloys which must be subsequently heat-treated, as it prevents the maximum properties being obtained, particularly so far as elongation is concerned. Accordingly, it is important to devote close attention to the placing of adequate runners and risers, and also to the melting operation to ensure the minimum amount of gas absorption in conjunction with an adequate final deoxidation treatment.

The main points to control in the founding of alloys in this group are given below.

Composition of Charge

The remarks as given for Group I apply also in this case. The presence of 0.75 to 1.0 per cent. zinc in the charge is desirable so that at least 0.5 per cent. remains in the final composition after allowing for melting loss. Where subsequent heat-treatment is intended lead must be definitely excluded.

Melting

Melting must be conducted rapidly in a furnace having a slightly oxidising atmosphere, such as is obtained by oil-firing or coke and forced-draft, if the best results are to be obtained in the production of alloys in this group. The use of manganese ore or other oxidising flux is also strongly recommended, and the charge basis should consist of prepared ingots rather than virgin metal, although the latter can be used if necessary. The following methods of handling the above raw materials should be adopted:—

A.—Using Prepared Ingots (100-*lb. Charge*):—

(1) Preheat the crucible to a bright red heat.

(2) Place manganese ore in the bottom of the crucible in an amount equivalent to 1 to 2 per cent. of the charge weight.

(3) Add the necessary amount of nickel pellet or 50/50 nickel-copper alloy shot. (No melting loss need be allowed on nickel content.)

(4) Charge ingots plus 50 per cent. returned scrap from previous melts.

(5) Cover the pot with the bottom of an old crucible; melt rapidly and induce adequate superheat.

(6) Draw the crucible from the furnace and remove the slag.

(7) De-oxidise before pouring with 4 to 6 ozs. of 15 per cent. phosphor-copper.

(8) Pour at a suitable temperature into moulds.

B.—Using Virgin Metals (100-*lb. Charge*):—

(1) Preheat the crucible to a bright red heat.

(2) Place manganese ore in the bottom of the crucible in an amount equivalent to 1 to 2 per cent. of the charge weight.

(3) Add the necessary amount of nickel pellet or 50/50 nickel-copper alloy shot. (No melting loss need be allowed on nickel content.)

(4) Charge best-selected or other high-grade copper ingots together with Muntz metal scrap (to make up zinc content) and returned or other approved scrap if available.

(5) Cover the pot with the bottom of an old crucible; melt rapidly and induce adequate superheat.

(6) De-oxidise with 4 ozs. of 15 per cent. phosphor-copper or other approved de-oxidiser. This should be tied to the end of an iron or steel rod and plunged to the bottom of the crucible.

(7) Add zinc to make up for the melting loss or for balancing the composition.

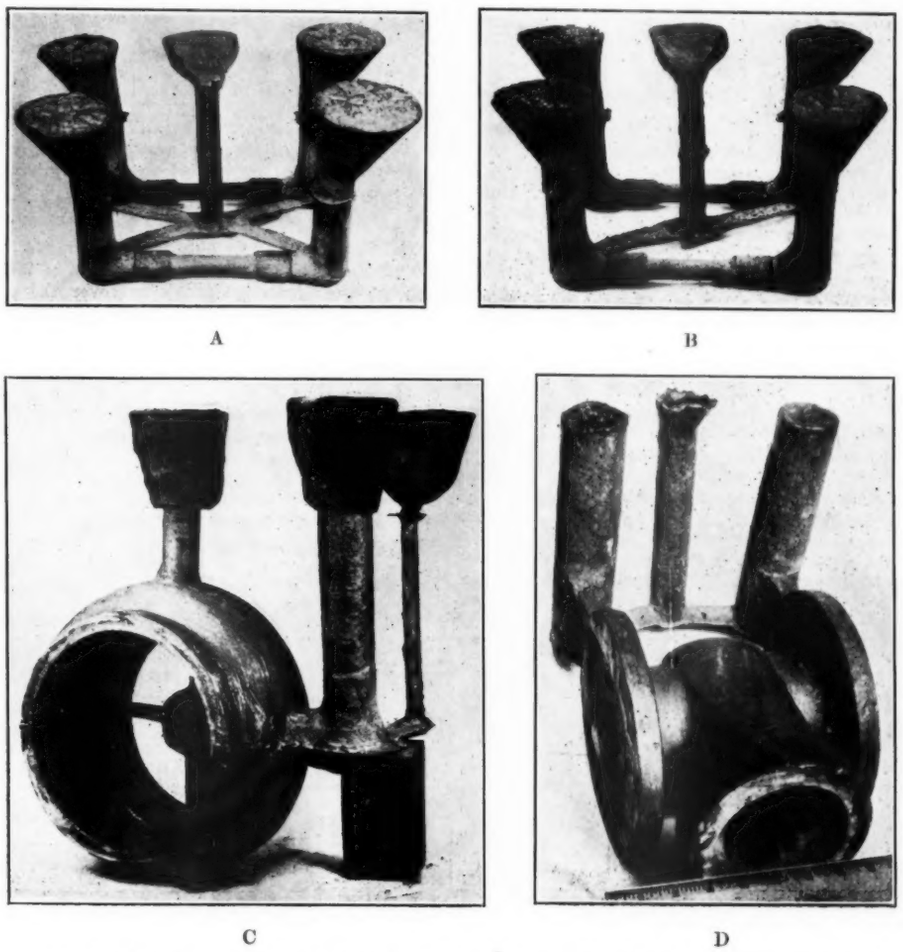
(8) Add the tin.

(9) Draw the crucible from the furnace and remove the slag.

(10) De-oxidise before pouring with 1 oz. of 15 per cent. phosphor-copper.

(11) Pour at a suitable temperature into the moulds.

Great care must be taken to ensure effective de-oxidation, and additions of metallic manganese or barium can be considered as alternatives to phosphor-copper. Excellent results have been obtained using both 0.05 per cent. phosphorus and 0.05 per cent. barium, but in the majority of cases good practical results are readily obtained by employing 0.05 per cent. phosphorus alone. The presence of a charcoal cover is detrimental to alloys in this group.



A B C D

FIG. 2.—USE OF CHOKE GATES ON BRONZE CASTINGS CONTAINING BETWEEN 5 AND 10 PER CENT. NICKEL, AS APPLIED TO: A AND B, TEST-BARS; C, SEAT FOR LARGE STEAM VALVE; D, 3-IN. VALVE BODY.

Pouring

Suitable pouring temperatures for alloys in this group are indicated in Table II.

Moulding Methods

Apart from the use of choke gates previously mentioned, care must be taken to ensure adequate feeding risers in order to obtain maxi-

mum density. Castings can be readily produced in green sand, dry sand or loam. Shrinkage, contraction and machining allowances are similar to the alloys without nickel.

III.—ADDITIONS OF NICKEL OVER 10 PER CENT.

Bronzes containing over 10 per cent. nickel are extensively employed for valve faces and fittings of all kinds for service with corrosive waters and steam. Furthermore, all the alloys in this range can be produced with a wide range of hardness values, when they are useful for certain bearing applications, such as rollers, sleeves and bushes, centrifugal pump packing rings, slide valves, etc., in view of their excellent wearing and corrosion resisting properties.

With rising nickel content all the bronzes become increasingly susceptible to the deleterious effect of water vapour, hydrogen, sulphur and carbon absorption during melting, and the presence of oxidising conditions together with the need of effective de-oxidation methods is of outstanding importance. Moreover, due to the high melting and casting temperatures employed, a rapid-melting furnace capable of superheating to over 1,400 deg. C. is required to obtain the best results.

Composition of Charge

There is a wide range of compositions in this group, most of which have been used for many years in various industrial applications and there is need for unification. Many alloys at present in service are intermediate between nickel-silver and bronze, and this compromise should be avoided if the best results are to be obtained.

TABLE II.—*Approximate Pouring Temperature for Nickel-Bronze Alloys.*

Alloy.	Composition.							Pouring temp. Deg. C.		
	Ni.	Sn.	Zn.	Pb.	Cu.	P.	Mn.	Light.	Med.	Heavy.
Group I.										
Gear bronze ..	1.5	11.5	0.5	—	86.47	0.03	—	1,150	1,110	1,060
Phosphor-bronze ..	1.0	11.0	0.5	—	87.25	0.25	—	1,100	1,060	1,020
Leaded phos.-bronze	1.0	11.0	0.5	5.0	82.25	0.25	—	1,090	1,050	1,010
Leaded phos.-bronze	0.5	11.0	0.5	10.0	77.75	0.25	—	1,080	1,040	1,000
Gunmetal	2.0	8.0	2.0	—	88.0	—	—	1,200	1,180	1,160
Gunmetal	4.0	10.0	2.0	—	84.0	—	—	1,200	1,180	1,160
Gunmetal	1.5	5.0	5.0	5.0	83.5	—	—	1,180	1,140	1,100
Leaded bronze ..	0.5	10.0	0.5	10.0	79.0	—	—	1,090	1,050	1,010
High leaded bronze	1.0	6.0	1.5	25.0	66.5	—	—	1,150	1,080	—
Group II.										
Gunmetal	5.0	5.0	2.0	—	88.0	0.03	—	1,220	1,200	1,180
Gunmetal	8.0	7.5	2.0	—	82.5	0.03	—	1,290	1,240	1,200
Group III.										
High nickel-bronze	20.0	7.0	0.5	—	72.0	—	0.5	1,340	1,300	1,260
High nickel-bronze	40.0	10.0	0.5	—	49.0	—	0.5	1,400	1,350	1,300

per cent. ferro-silicon or by silicon-copper. Up to 50 per cent. of returned scrap can readily be employed without detriment to the majority of the alloys in this group.

Melting

The best results are obtained by using oil or forced-draft coke-fired furnaces. If the latter be employed, it is preferable to cover the crucibles to exclude particles of coke. Bronzes containing over 10 per cent. nickel can absorb carbon, and under certain circumstances this will react with oxides to form carbon monoxide, a gas which is very soluble in the molten alloy but which is much less soluble in the solidifying metal. This results in the liberation of gas on or around solidification, giving rise to porosity and blowholes. The defect can be readily detected at the time of pouring, as the metal in the runners and risers, instead of showing a shrinkage cavity as it normally should, actually rises and solidifies with a convex surface. This trouble, which is liable to occur in the founding of all high-nickel bronzes, is essentially due to the melting operation and can be simply overcome by preventing carbon absorption through the use of oxidising conditions in conjunction with adequate de-oxidation.

It is a wise safeguard in melting alloys in this group to use a manganese ore slag or, alternatively, to oxidise the metal by the addition of black manganese-dioxide about 10 minutes before pouring. In this latter instance the oxidising agent should be introduced by means of a suitable plunging device and moved up and down in the metal in the crucible. In most cases, however, the use of a manganese ore cover is to be preferred as the more positive method of obtaining the best results. Oxidising treatment by one or other of the above methods is essential when melting is conducted in reducing atmospheres such as are common to natural-draft coke-fired furnaces.

As the nickel content increases, the need for more effective de-oxidation methods must also be emphasised. It is advisable to use manganese, magnesium, silicon or phosphor-copper for this purpose, according to the type of bronze being produced. The following outlines a typical method of charging raw materials and de-oxidation practice:—

Charge based on 50/50 Nickel-Copper Alloy Shot:—

(1) Preheat the crucible to a bright red heat.

(2) Place manganese ore in the bottom of the crucible in an amount equivalent to 2 to 3 per cent. of the charge weight.

(3) Charge 50/50 nickel-copper alloy shot together with a small amount of metallic manganese (2 ozs. manganese metal per 100 lbs. total metal charge).

(4) Add best-selected or other high-grade copper ingots together with Muntz metal scrap (to make up zinc content) and returned scrap from previous melts if available.

(5) Cover the pot with the bottom of an old crucible; melt rapidly and induce adequate superheat.

(6) De-oxidise in the furnace by further addition of manganese (2 ozs. of manganese metal, per 100 lbs. total metal charge, tied to the end of an iron or steel rod and plunged to the bottom of the crucible).

(7) Add zinc if necessary for balancing composition (normally none should be required).

TABLE IV.—*Approximate Percentage Analysis of Materials Used for Making Nickel Additions.*

	Ni.	Cu.	Mn.	Si.	Fe.
Nickel pellets ..	99+	Trace	Trace	Trace	Trace
50/50 nickel-copper alloy shot ..	50	50	Trace	Trace	Trace
Silicon-free Monel pig	66	30	½	Trace	2
Monel pig	66	30	½	1	2

(8) Add the lead (if the alloy be free from silicon).

(9) Add the tin.

(10) Draw the crucible from the furnace and remove the slag.

(11) De-oxidise before pouring with magnesium (¾ oz. of magnesium, per 100 lbs. total metal charge, plunged to the bottom of the crucible).

(12) Pour "hot" into moulds.

When silicon additions are required to obtain high hardness, the necessary amount of silicon-copper or 75 per cent. ferro-silicon can be added with the 50/50 nickel-copper shot; alternatively, silicon containing Monel pig can be employed. Lead even in small amounts is extremely deleterious to silicon-containing nickel-bronzes, giving rise to porosity and coarse structures, and should accordingly be omitted from the composition. Table IV gives the analysis of nickel-containing raw materials which will be of assistance in making up metal charges for various purposes.

Pouring

The pouring temperature for bronzes containing over 10 per cent. nickel will depend to some extent on the amount of nickel present (see Table II) and the design and section of casting being produced. As a rule, however, they should be poured "hot," and certainly not under 1,300 deg. C. Table III indicates the effect of pouring temperature upon the mechanical properties of a 20 per cent. nickel-bronze.

TABLE III.—*Effect of Pouring Temperature on the Mechanical Properties of Cast 20 per cent. Nickel-bronze.*

Composition, per cent.						Pouring temp. Deg. C.	Tons per sq. in.		Elong. per cent. on 2 in.	Izod impact (ft.-lbs.).	Brinell No. 1,000 kg.	Density.
Ni.	Sn.	Zn.	Pb.	Cu.	Mn.		Y.P.	M.S.				
20.98	5.24	0.80	0.13	72.60	0.15	1,400	15.2	25.6	14.0	19.0	107	8.914
						1,350	14.4	26.8	14.5	11.0	107	8.758
						1,280	15.2	22.6	7.25	9.0	107	8.781
18.84	7.17	0.68	0.13	73.10	Mg. (trace)	1,400	16.4	23.2	3.0	5.0	134	8.833
						1,340	18.6	22.1	2.25	5.0	143	8.776
						1,300	18.6	26.9	3.5	3.0	125	8.782
						1,240	17.6	25.2	3.0	4.0	138	8.641

Note.—Freezing point of bronze containing 20.98 per cent. nickel determined at 1,150 deg. C., and 1,140 deg. C. for 18.84 per cent. nickel alloy.

For example, it is not uncommon to find 7 per cent. zinc associated with 7 per cent. tin. To obtain improved results it is desirable that high zinc percentages be omitted from these alloys, although, as previously mentioned, a small amount of zinc up to 1 per cent. assists founding. For bearing purposes the addition of lead is sometimes necessary, but this element should be excluded from compositions containing silicon. If an appreciable degree of ductility is desired in the cast state the tin content should not exceed 6 per cent., otherwise the alloy will have to be annealed. Additions of metallic manganese

Moulding Methods

In view of the high casting temperature employed, it is important to use refractory and permeable sands together with well-vented moulds. Small nickel-bronze castings in this group can be readily made in green sand,* but in the manufacture of medium and large castings dry or skin-dried moulds, in conjunction with a suitable protective black-wash, are to be preferred. Centrifugal-casting methods are particularly advantageous for the production of high-nickel bronze valve faces, etc.

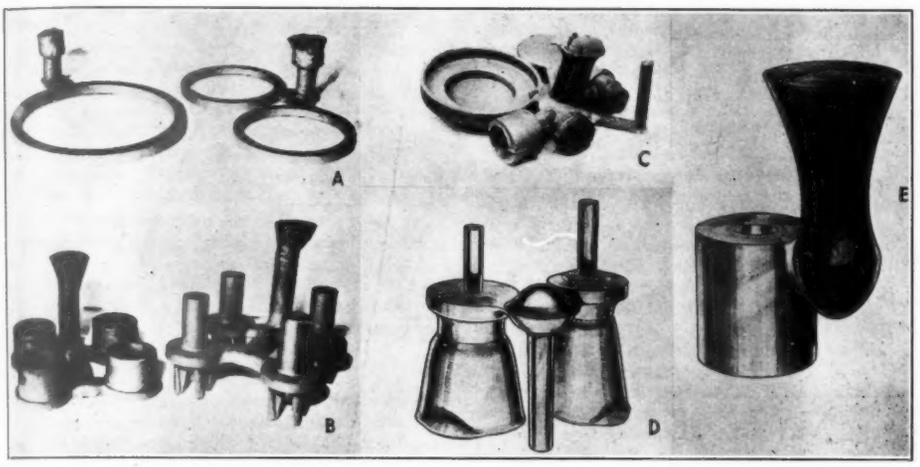


FIG. 3.—MISCELLANEOUS HIGH-NICKEL BRONZE CASTINGS, SHOWING GATING AND RUNNING METHODS.

A, Sluice Valve Seats (Glenfield & Kennedy, Limited); B, Pump Valves and Seats (Glenfield & Kennedy, Limited); C, Miscellaneous Castings (Gummers, Limited); D, Steam Valve Lids (Steven & Struthers, Limited); E, Bearing Bushes for Chemical—a second Casting can be attached to the other side of the In-gate (B. Rhodes & Son, Limited).

Alloys in this group have a slightly higher shrinkage than ordinary bronze, and are fragile at high temperatures. Suitable precautions should be taken, therefore, to ensure that moulds and cores are not unduly strong; otherwise cracking may occur during cooling. A subsidiary cause of hot-cracking is due to sulphur pick-up during melting, but this can be prevented by the use of a suitable slag cover as recommended.

In the actual running of the castings, choke gates are advisable wherever possible, and in view of increased liquid shrinkage the risers should be slightly larger than those normally used for bronze founding. Fig. 3 illustrates various methods of placing runners and risers which have been found to give good results in practice. The ingate should be as short as possible in order to prevent undue cooling of the metal. When choke gates are not employed, extra machining allowances over that usually considered normal for gunmetal and bronze castings should be given on all top surfaces.

In the casting of high-nickel bronzes, the choke gate should be designed in such a manner as to prevent spraying or excessive turbulence of the metal when it enters the mould. The most common way of ensuring such conditions is to make the sectional area of the ingate at the casting larger than the main down-gate. Due to the high pouring temperatures employed, care must also be taken to round off the edges of the runner to prevent erosion or breaking away of the sand with consequent production of slag or dirt spots in the casting. The runner basin should be kept full of metal when pouring. Risers are imperative on alloys in this group, and to obtain the most effective feeding action the metal in them should be at a higher temperature than the metal in the parts to be fed. To obtain this, it is good practice to stop pouring when the metal in the mould enters the bottom of the riser and to fill up the riser with hot metal from the crucible. This operation should be conducted with as little agitation as possible.

TABLE V.—*Fluidity Test Values for High-Nickel Bronzes (Group III) in Comparison with Ordinary Gunmetal and Phosphor-Bronze.*

Composition. Per cent.								Covering temp. Deg. C.	Fluidity test (inches).
Ni.	Sn.	Zn.	Pb.	Cu.	P.	Mn.	Fe.		
20.98	5.24	0.80	0.13	72.60	—	0.15	—	1,400 1,350 1,280	18 4 Nil
20.08	6.22	0.64	Trace	72.70	—	0.28	Trace	1,340	9
18.84	7.17	0.68	0.13	73.10	—	—	—	1,400 1,340 1,300 1,240	30 23 10 7
—	7.40	3.24	3.90	85.46	—	—	—	1,220 1,160 1,120 1,060	11 9 4 Nil
—	10.82	—	0.09	88.74	0.27	—	—	1,150 1,100 1,050	7 1 Nil

Fluidity of Nickel-Bronzes

All the nickel-bronzes have a high degree of fluidity, and consequently castings in these alloys give good mould detail. One of the curious effects which nickel has on bronzes is the power of imparting fluidity or running power to the metal. In 1932, Pilling and Kihlgren* investigated the effect of small additions of nickel (typical of the alloys in Group I), and found that in none of seven types of foundry mixtures examined was the fluidity impaired. In the majority of cases running power was appreciably increased. The above remarks also apply to bronzes containing high nickel percentages, and Table V tabulates the fluidity values obtained in practice in comparison with ordinary gunmetal and phosphor-bronze, using the test method as put forward by Saegar and Krynitsky, illustrated in Fig. 4. It is interesting to observe that, within the range of suitable pouring temperatures for the individual alloys, bronzes containing around 20 per cent. nickel are much more fluid than ordinary gunmetal and phosphor-bronze of similar tin content. Although nickel bronzes possess greater fluidity, they are not subject to mould penetration like phosphor-bronze and give cleaner casting surfaces. This may seem surprising to many foundrymen, but it can possibly be explained by the fact that mould penetration is more directly affected by such properties as metal viscosity or surface tension. So far as phosphor-bronze is concerned, it is extremely probable that the question of mould penetration is not due to running power but due to the fact that this alloy has a low surface-tension value when liquid, in conjunction with the absence of oxide films, which permits penetration to take place with consequent increase in friction between mould and metal. On the other hand, additions of nickel quite probably increase surface-tension values and cause the formation of a thin oxide film which decreases friction between mould and metal, thus giving increased fluidity.

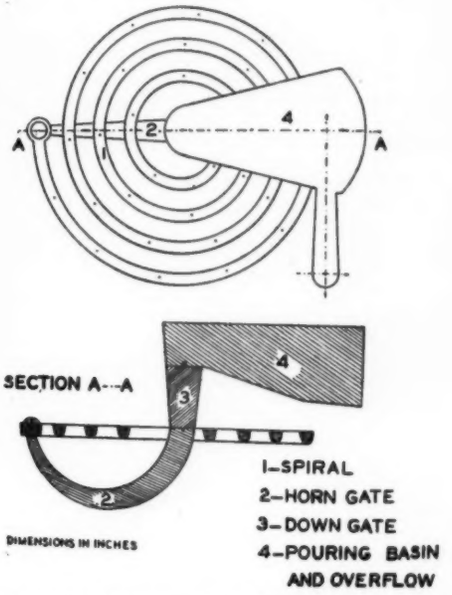


FIG. 4.—FLUIDITY TEST PATTERNS (SAEGAR AND KRYNITSKY).

I.C.I. and Light-Metal Alloy Manufacture

In January, 1937, Imperial Chemical Industries, Limited, announced its entry, through its subsidiary I.C.I. Metals, Limited, into the light-metal alloy industry as a manufacturer of strip and sheet to the various D.T.D. and British Standard specifications. Since then the company's interest in this field has become such that it has been decided to embark at once upon a major scheme of development. This will involve the installation of extensive new equipment at the company's works at Witton, near Birmingham.

* Dusting mould face with pease-meal or flour assists casting finish.

* "Casting Properties of Nickel Bronzes," N. B. Pilling and T. E. Kihlgren, Trans. A.F.A., 1932.

The Modern Manufacture of Machine-Tool Castings

DISCUSSION AT BRADFORD CONFERENCE

MR. J. BLAKISTON'S Paper on "The Modern Manufacture of Machine-Tool Castings" (see the JOURNAL for July 7, pages 3-7) gave rise to one of the most interesting discussions at the Bradford Conference of the Institute of British Foundrymen. An extraneous subject introduced was the addition of up to 2 per cent. of clean ribbon turnings or sheet steel into ladles of liquid cast iron. Other points dealt with were trap runners, composition of the iron, design, and running problems for long castings.

Phosphorus Content for Machine-Tool Castings

The discussion was opened by MR. A. J. SHORE, who referred to the table (in the section of the Paper headed "Melting Losses and Gains") comparing the compositions of cupola metal and Brackelsberg rotary-furnace metal, and pointed out that the phosphorus content of the cupola metal was 0.78 per cent., and the phosphorus content of the rotary-furnace metal was 0.40 per cent. He imagined that, unless borings or some material of that sort, were used in the Brackelsberg furnace, the base iron was more expensive in that case than in the case of the cupola-melted iron. Yet the physical properties were said to be roughly the same, and he asked whether the example was given in the Paper to damn the rotary furnace, because it did not show up very well on the figures given.

Inoculation by Steel Sheet Additions

Discussing the inoculation of iron, he asked whether the author had had experience of adding steel to the ladle in the form of very thin sheet (not molten steel). It was his experience that as the result of adding 2 per cent. of steel at the bottom of the ladle (using 5 cwts. of iron), there was a definite improvement of the density or soundness of the thick sections, although there did not seem to be any particular reason for that improvement. The material used consisted of clean pressings, the waste from the press shop. It had a certain amount of fat on it, and it had been suggested that perhaps the improvement of properties of the castings was due to the fat "shaking up" the metal in the ladle.

The importance of design seemed so obvious, he continued, that it should not need comment; yet the improvement of design from the point of view of moulding seemed to be the last matter which designers considered. At his works they had really got down to the problem, and by improving the design of castings from the moulding point of view they had been able to achieve at least 25 per cent. increase of production, and to turn out a better job. That meant that previously they had been doing things which were not necessary; they had effected improvement by dispensing with things that were unnecessary, by providing a little more taper here and there, and so on.

Reason for Low Phosphorus Content

MR. J. BLAKISTON, dealing with the comment upon the table showing the compositions of the cupola metal and the Brackelsberg rotary-furnace metal, and the suggestion that the latter metal was more expensive than the former, said that in the instance given it was decided as a safety factor to reduce the phosphorus content of the rotary-furnace metal in order to maintain density at the bottom of deeply-machined Tee slots. It was a question of the founder suiting his methods to the design, and it was a well-known method to reduce the phosphorus content to below 0.5 per cent. He believed there was no increase of cost of the charge; the result desired was achieved by adding steel to the Brackelsberg furnace and carburising it with petroleum coke. Actually one could make a synthetic iron in a rotary furnace by using 100 per cent. steel and carburising it with petroleum coke.

He had never attempted the addition of sheet steel to the ladle, but the reference recalled to his mind a method once adopted by an old foundry foreman who was required to make cast iron which would bend. He had filled a small ladle with foundry sprigs and had poured in hematite iron from the cupola.

Effect of Composition

MR. F. C. PEARCE, commenting on the author's statement that the rotary furnace delivered a better iron than the cupola, asked in what respect it was better. For example, referring to the table showing the compositions of the cupola and the rotary-furnace metals, he asked whether, if the cupola would give a metal having a composition equal to that specified for the Brackelsberg rotary furnace, the Brackelsberg furnace metal would be any better than the cupola metal. Or was the Brackelsberg furnace metal better merely because it had a lower total carbon content than the cupola metal?

MR. BLAKISTON said the question was answered by the fact that a casting from a rotary-furnace iron showed much more even grain in varying sections than did a casting from the cupola iron, as had been proved by breaking up certain castings. There was certainly a greater tendency to produce open iron from the cupola than from the Brackelsberg furnace.

Ladle Additions and Ribbon Turnings

MR. F. J. COOK (Past-President), discussing the addition of thin steel sheet in the ladle, said he had had to produce very large quantities of machine-tool castings, and for small slides it was the practice in some foundries to use the ribbon turnings from automatic lathes, which turnings were extremely thin and were kept clean—they were usually supplied by the people who took the castings—and there was no doubt that a very definite improvement was effected in the texture and closeness of the metal, and a reduction of sinking in deep parts.

With regard to foundry difficulties arising from the design of the castings, he claimed that a great deal of the trouble experienced was due to the foundrymen themselves, and he asked how many foundrymen could criticise a drawing when it was on the drawing board. It was very easy to be wise after an event; but if the foundryman was to be able to effect improvement in regard to design he must be able to criticise a drawing at its inception. It had been his good fortune for very many years to be able to ensure that no drawing was traced unless he had approved it. In the case of one design of engine, a saving of at least £100 was effected in the production of each individual engine as the result of alteration of the design, without detriment to the efficiency of the job.

MR. BLAKISTON, endorsing Mr. Cook's remarks, said he believed the Institute was doing its best to make practical foundrymen realise how essential it was to secure technical training, so that they could understand the points of view of others and could explain their own point of view more graphically than they had been able to do previously.

Value of Phosphorus Content

MR. P. A. RUSSELL, B.Sc., commented that the analyses the author had given in Table I of irons used in machine-tool castings were representative of practice throughout the country; but he asked for some further information with regard to phosphorus. In the Type 2 iron in Table I, the phosphorus content was 0.70 per cent., and that agreed with his own practice; he liked low-phosphorus iron for pressure work, but for machine-tool work a proportion of phosphorus was an advantage. In the table given in the Paper to indicate the compositions of cupola metal and Brackelsberg rotary furnace metal, the latter metal had the lower phosphorus content, whereas one would imagine that it could have a higher phosphorus content than the cupola metal. In the case of the cupola, having the higher carbon content, and where there was greater risk of the carbon approaching the eutectic point, there was more of a case for low phosphorus content; in the Brackelsberg furnace metal, in which the carbon and silicon could be controlled very well, he would have thought that one could afford to maintain an even higher phosphorus content than in the Type 2 iron. In machine-tool irons, phosphorus was a valuable constituent; its effect on wear was quite distinct, and when looking at a machine-tool casting which had been in use for some time one could tell whether or not the phosphorus content was high by the way in which the phosphide eutectic stood out.

Fluidity of Inoculated Irons

Whilst endorsing the author's remark that it was difficult to carry out inoculation in small quantities, he would not like to leave the impression that one could not make small quantities of inoculated irons; he had done it in cwts. at a time. It was a question of tapping temperature to start with. If the iron were hot enough it would stand inoculation in small quantities. Incidentally, he said it was his experience that inoculation rendered an iron more fluid; for a given temperature and class of iron, thinner castings could be run in inoculated iron than in straight iron.

Discussing the trap runner illustrated in Fig. 7 of the Paper, he said he would have thought that it was rather dangerous to use. If the runners were well organised, and the diameter of the downright from the pouring basin were greater than the downright into the casting—there were also different levels, and so on, to be considered—it might be all right. But in the trap runner illustrated there seemed to be very grave risk of the metal running out of the trap basin at a greater speed than that at which it could enter from the pouring basin, so that the slag would be carried into the casting. He would have thought that a scheme with a tangential arrangement would have been more effective. The trap runner illustrated occupied much room.

Limit of Phosphorus Content

MR. BLAKISTON, referring to the table showing the compositions of cupola metal and the Brackelsberg rotary furnace metal, said that in fact the cupola-melted sample was taken from a casting supplied from an outside source, and the Brackelsberg-furnace-melted sample was taken from a similar casting he had made. There was no definite attempt to match the analyses, but he endorsed Mr. Russell's statement that there was a higher phosphorus margin in the Brackelsberg furnace metal than in the cupola metal. It paid always to maintain the phosphorus content as high as one dared without running into the bugbear of all machine-tool casting moulders, *i.e.*, open Tee slots. Not only did it give the casting a superior finish, but it also enabled the machine shops to use high cutting speeds without plucking.

With regard to inoculation, he said that foundry managers very often had to make the best of the plant they had available, and when he had mentioned 10 cwts. as the minimum weight for inoculation, he had meant that it was

more or less a safe weight to run commercially with the plant that was probably available. With the necessary plant and with superheated iron, no doubt one could achieve good results with much smaller quantities of metal.

Trap Runners

As to the trap runner illustrated in Fig. 7, he said the first entry from the pouring basin to the trap basin was achieved by means of a double runner, so that it provided double the area of that of the runner into the casting. That afforded a sufficient margin of safety, and there was no possibility of the metal from the trap basin carrying the slag into the casting. The proof of the pudding was in the eating, and the volume of dirt precipitated in the trap basin was surprising. He was observing the different results obtained with different cupola cokes; and when using cokes of very similar analyses, there were definite variations in the dirt precipitation when making similar castings through the trap runner. He hoped to collect further data on that subject.

Dangers of Ladle Additions

MR. REYNOLDS said that, in spite of the references made to the successful results accruing from using steel turnings or pieces of thin steel sheet in the ladle and pouring metal on to them, he was opposed to that practice as against the more normal and constitutional methods. He would like to know what advantageous effect the steel turnings or sheet could have, as against steel which was added either in the cupola direct or (where the quantities were small) steel which was melted in the crucible, with or without ferro-alloys, and added to the ladle in order to strengthen the iron. The addition of steel turnings and the pouring of hot metal over them seemed to be rather a hit-and-miss business, for there seemed to be danger of the turnings floating up, becoming entrapped in the runner and, therefore, into the casting. He could foresee many disadvantages arising from that practice as against the more normal practices of alloying in the cupola or by means of ladle additions.

MR. BLAKISTON replied that he, too, was very much against ladle additions unless they were necessary for inoculation. The correct method of making additions was to make them on the charging platform, in weighed amounts. There was always a tendency to produce a " plum-pudding " effect with ladle additions, and there was also the chilling effect on the metal.

Ladle Additions Upheld

MR. D. SHARPE was thoroughly in agreement with the practice of using thin steel sheets at the bottom of the ladle; it was common practice in a number of foundries where they required to stiffen up iron for a few castings. The thin sheets were placed at the bottom of the ladle, or fed into the metal in ladle, and the mixture was then poured. That method was giving satisfactory results every day. It was worthy of note that the practice was so common, despite the common agreement that additions should be made through the melting medium.

MR. V. C. FAULKNER (Past-President) asked what percentage of steel sheet could be added to the ladle. A figure of 2 per cent. had been mentioned, and he asked whether that represented the economic limit.

MR. SHARPE said he would not like to give a definite figure. At his own works the matter was left entirely to the judgment of the foreman and in some cases to the man responsible for making the job. The practice was rule-of-thumb, as were many others. But in the light castings trade it was a common practice to use an unqualified quantity, being left to the judgment of the man responsible for the job.

Selected Additions Essential

MR. F. J. COOK agreed that, if one had to deal with a sufficient quantity of a mixture, it was better to make additions in the usual way—either by making alloys and adding them to the ladle or, better still, by putting the additions through the melt. But perhaps there was some misapprehension with regard to the addition of turnings to the ladle. He did not mean that the ordinary shaving turnings were used, but the turnings which came from the lathes in the form of ribbons, about 1-in. or 1½-in. wide and only a few thousandths of an inch thick. They were added in definite quantities—1½ per cent. was added in 2-cwt. ladles. The practice was adopted in cases where a few castings of a certain composition were required in the course of a day's run. The turnings were red hot, as the result of the heat at the bottom of the ladle, before the metal came on to the top of them, and there was no question that very good results were obtained regularly.

Limiting Factors

MR. A. J. SHORE added that the addition made to the ladle was carefully weighed and was perfectly free from rust, though it had some fat on it. The strips were 1-in. or 1½-in. wide, and they were thin. They were used for special jobs, where one required to be quite certain that the ladle contained the correct metal. If a small amount were added in the cupola, it might be missed, whereas one could be certain that it was in the ladle if it were added there. The amount used was, roughly, 2 per cent., and he reckoned that 2 per cent. added in that way was as good as 5 or 7 per cent. added in the cupola. He did not know why, but it worked out in that way.

A Historic Practice

MR. A. HARLEY (past-President) recalled that, when watching the casting in the moulding shops at Coalbrookdale about 40 years ago, he had noticed an old man about 70 years of age dropping thin sheet steel very carefully into a big ladle of metal. In reply to questions, the old man had said that better castings were made as a result; and that was in fact the case, for the castings were excellent. Further, the old man stated that his father and his grandfather had followed the same practice. Therefore, the practice of adding sheet steel to cast iron in the ladle had been followed for generations at Coalbrookdale. The method might not be the most scientific, but Mr. Harley believed it was far better than the method of putting small quantities through the cupola. A quantity of 2 or 3 per cent. could be added quite easily. The old moulders of the past had realised, by observation, that for certain classes of work cupola metal was rather too grey and might be inclined to draw, and their method of adding sheet steel gave the metal a closer grain.

Running Long Plane Beds

MR. A. MARSHALL, referring to the plane bed illustrated in the Paper, asked for Mr. Blakiston's opinion about running from one end, and whether there was a maximum length that could be run from one end. If the casting were run from both ends, one ladle was standing, and the temperature was dropping.

Trap basins in his experience were successful, and collected a considerable amount of slag which otherwise would enter the castings.

Dealing further with the pouring of machine beds, he suggested that where they were poured from both ends, there was at some points a tendency to slight oxidation and for particles to be picked up, producing porosity in the castings at those points. With regard to design, he said that where two ribs met, there was naturally a certain amount of porosity. He had tried chill nails, but the hot metal seemed to nip them off.

A Fourteen Feet Limit

MR. BLAKISTON replied that the plane bed of which a photograph was shown in the Paper was 40 ft. long. It was necessary to run the metal along the bottom on chills, to counteract any tendency to draw created by the cross ribbing of the casting. A distance of 20 ft. was a long way to run metal on chills, but it was achieved successfully.

He was against pouring long castings from both ends; where the two streams of metal met there was always a tendency, not for a cold lap, but for a deposit of oxidised matter. When that matter existed in the metal, there was increased tendency to pick up blacking or skim the sides of the mould, and patches of " gas-holing."

The limit of length for running from one end successfully was about 14 ft.

In the Brackelsberg furnace practically any temperature could be achieved up to the temperature at which the lining was injured. The metal must be fairly hot when producing high-duty cast irons. But the lower the temperature at which one could cast successfully, the longer the life of the refractories; the hotter the metal, the shorter the life of the lining.

Dealing with the question of porous patches in ribbed castings, he said that it paid to slip in a little core between ribs and corners at such places, even if only of ½-in. diameter; if one could not do that, a small steel bar could be used.

MR. V. C. FAULKNER suggested that those interested in the addition of thin sheet steel to the ladle might study the American Exchange Paper presented two years ago by Mr. Judson. That Paper was very valuable; the author was mixing in the liquid form two categories of metal in which some auto-inoculation had taken place.

Catalogues Received

Foundry Equipment. J. W. Jackman & Company, Limited, Vulcan Works, Blackfriars Road, Manchester, have issued a second edition of their abridged machinery catalogue. This brochure emphasises in the strongest possible manner the great strides constantly being made in the mechanical side of foundry practice, and shows how essential it is for executives constantly to be on the look out for new machines. The writer confesses that he was unaware that Jackman's had designed and placed upon the market a desilting plant. This looks a thoroughly workmanlike job and is, of course, of increasing interest to the industry. The catalogue is built up on the loose-leaf system and is divided into sections covering melting appliances, sand-preparing plant, moulding machines, air appliances and testing machines. In practically every section new machines are shown. A commendable practice is followed throughout the catalogue by giving code words for each type and size of machine. At the end of the catalogue there are three pages devoted to " Useful tables for foundrymen "; these have been particularly well chosen. This catalogue is to be made available to our readers on application to the issuing company. The writer strongly recommends that advantage be taken of this offer, as a thorough revision has been effected, and it is now virtually a text-book on up-to-date foundry plant.

Safety Clothing. A leaflet received from Kenneth Hill & Company, Limited, of St. Stephen's House, Victoria Embankment, London, S.W.1, describes and illustrates a range of protective clothing for use by operators of sand and shot blast rooms, together with some details of nozzles and hose. The helmet illustrated includes special features in connection with the vision window; not only is this dust-proof and easily removable, but it is mist-proof also. In the " Blast clean " suit, the front part is made of rubber sheet, whilst the back is of woven material to provide proper ventilation and coolness. The gauntlets shown are externally reinforced with *crêpe* rubber, the object being to ensure longer life.

A Study of Mould Surface Defects

By H. W. DIETERT*

Introduction

It has been said that to save the mould surface is to save all. This statement is not far from correct when it is considered that, providing the mould surface does not peel off, crack, buckle, burn-on, scab, cut or pull down, a foundryman is quite certain of producing a good casting. The object of this article is to familiarise foundrymen with the way in which moulding sands and cores may be tested at high temperatures to determine how the sand will behave when heated to temperatures identical to the pouring temperatures of the molten metal.

Method of Test

With a sand rammer, the sand in question is rammed in the form of a cylindrical sand specimen 2 in. in length. For tests in this article 1½-in. dia. specimens were used. Equipment was also available to test specimens 2 in. in diameter. Test results agreed very closely for these two

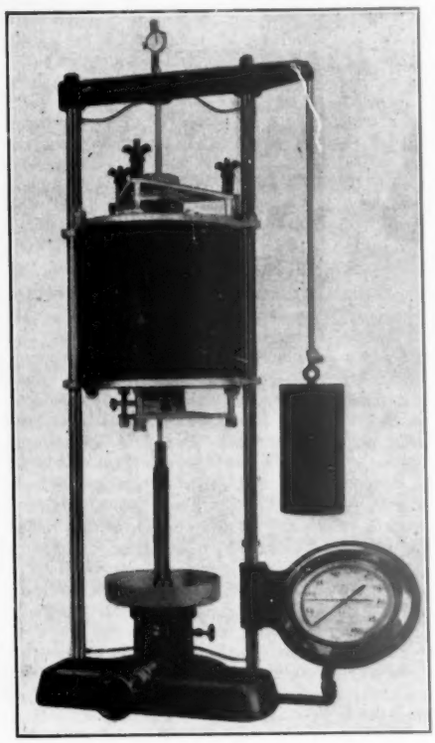


FIG. 1.—DILATOMETER ADAPTED FOR SAND TESTING.

different-sized specimens. The time required is much less for the 1½-in. dia. specimen, so it was used for this investigation.

The rammed sand specimens were inserted in the dilatometer, Fig. 1, and with the furnace of the dilatometer at 1,370 deg. C. it was quickly lowered around the sand specimen simulating mould conditions. The expansion or contraction of the sand specimen was read from the dial indicator and recorded in thousandths of an inch per linear inch of the sand specimen. Tests were also conducted where the sand specimen was heated gradually at the approximate rate of 5 deg. per min.

Sand Behaviour at Elevated Temperatures

The silica sand grains of a sand expand when heated. This expansion may be as large as 0.040 in. per linear in. for a very refractory oil-bonded core or there may be no expansion, for the expansion of the sand grains was cancelled by materials that contracted more than the sand grains expanded. The clay bond contained in a moulding sand or core sand will contract when heated to elevated temperatures. Bonds of low refractoriness may start to contract at temperatures as low as 870 deg. C., while others of high refractoriness may require temperatures higher than 1,315 deg. C.

Cereal binders, coal dust, wood flour and other combustible materials will burn out at a fairly low temperature, thus causing voids to be formed in the mould mass. Into these voids the expanded sand grains may move, thereby cancelling or reducing expansion. Most clay bonds in sand may be considered as a fluxing element in connection with silica. Therefore, the greater the quantity of bond present, the lower the refractoriness and greater the contraction.

The expansion of a moulding sand starts at such a low temperature as 260 deg. C. and continues up to a possible temperature of 870 deg. C. Therefore, sand first expands at relative low temperatures. The face of the mould may go through its expansion cycle in a few seconds before a mould is completely poured. The contraction cycle follows the expansion cycle and requires a considerably larger quantity of heat at high temperature. It is apparent, then, that the mould surface goes through a contraction cycle only on relatively large castings poured with hot metal.

The heat flow through a sand substantially varies directly in proportion to permeability. That is, as the permeability of mould surface increases, the heat flow into the sand increases, causing greater contraction. Thus, mould dusts and washes help to reduce contraction.

In this study one important condition to remember is that timing of these two opposing volume changes will also affect the stresses imposed on the mould surface. Where a high-sintering bond is used the contraction will start late in the cycle and the amount of contraction will be small. This condition would be desirable for hot metal and large castings. When a low-sintering clay is used in large quantities, the contraction will take place early in the cycle, and the amount of contraction probably will be large enough to pull a mould surface apart, allowing molten metal to flow behind a peeling of the mould surface. When a low-sintering type of clay is used a small quantity should be used to increase sintering temperature. Work the sand at a conservative strength, for example, 6.5 lbs. green compression.

In the case of light castings, the quantity of heat imparted to the sand is small, just sufficient to expand the sand grains in most cases. The sand grains in a mould of this type should be well saturated with a clay bond to minimise the expansion. Such moulding sand should not be worked at low strength, such as 4.5 lbs., but at 6.5 to 7.5 lbs. and rammed to a medium soft mould hardness of 55 to eliminate the usual " rat tail " defect.

Demonstration Tests

These statements are the result of many tests on sand producing good and defective castings. The sand specimens shown in Fig. 2 prove helpful in visualising what occurs on the surface of a mould when a mould is poured. These sand specimens were subjected to a shock immersion temperature of 1,370 deg. C. The sand specimen at the left hand shows iron shots that bleed from the interior of the specimen; note also the cracks into which molten metal could flow, causing " fissures."

The sand specimen in the centre shows the surface of the sand peeled off due to a compressive force imparted by the expansion of the sand grains. This defect of the sand would result in a " cope pull-down " or " buckle." Radiated heat from molten metal against the cope of the mould is just sufficient to cause sand grains to expand rapidly. The third specimen on the right-hand side of Fig. 2 was subjected to 1,370 deg. C. for a longer period, as would be the case in a mould for a heavy-sectioned casting. The sand composition was just proper to cause the sand to have a high expansion and contraction. A portion of the sand specimen peeled off and then the contraction of the specimen opened up this portion of the sand. If molten metal was present, it would flow behind the peeled-off portion and cause a " scab defect."

TABLE I.—*Properties of the Samples shown in Fig.* 3.

Sand.	Moisture. Per cent.	Permeability.	Green compression. Lbs.	Dry compression. Lbs.	Resilience.	Clay. Per cent.	Sintering. Deg. C.	Expansion.	Contraction.
A ..	7.2	23	6.1	52.0	128	14.2	1,280	+ 0.020	— 0.047
B ..	8.2	44	16.3	55.0	277	28.1	1,391	+ 0.015	— 0.004

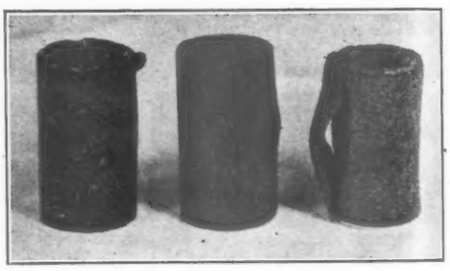


FIG. 2.—THE SAND AT THE LEFT SHOWS PARTICLES OF IRON; THE CENTRE ONE BUCKLE, AND THAT AT THE RIGHT SHOWS A SCAB.

TABLE II.—*Properties of the Samples illustrated in Fig.* 4.

Sand.	Moisture. Per cent.	Permeability.	Green compression. Lbs.	Dry compression. Lbs.	Resilience.	Clay. Per cent.	Sintering. Deg. C.	Expansion.	Contraction.	Mould hardness.
C ..	3.9	120	4.1	13.5	60	7.0	1,310	—	— 0.022	85
D ..	5.3	90	3.7	50.0	111	6.5	1,337	+ 0.008	— 0·012	55
E ..	4.7	110	6.7	25.0	114	9.7	1,326	+ 0.014	— 0.009	87

Correction of Rat-Tails

Testing sand that produces rat-tail defects and sand that works well on light-sectioned casting, it was found that the sand that rat-tailed would show cracks when subjected to the dilatometer test, as is shown in Fig. 3, and Table I, where the sand A at the side produced rat-tail defects, while the sand B did not produce any rat-tails. It is free of surface cracks when subjected to the

* President, Harry W. Dietert Company, 9330, Roselawn Avenue, Detroit, Michigan.

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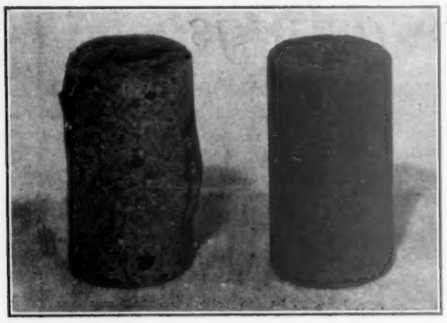
dilatometer test. When the green strength of the sand A is increased to 16.3 lbs. green compression, then the sand will hold together and not rat-tail. This increase of strength will also cause the sand to ram to the required mould hardness without having the sand grains compressed so closely together.

Correction of Buckle

Since a " buckle defect " frequently appears in copes of moulds made with a sand low in bond



A B

FIG. 3.—THE " RAT-TAIL " DEFECT SHOWING DISAPPEARANCE WITH INCREASED GREEN BOND STRENGTH.

and moisture due to a large percentage of expanding silica being present, a very instructive series of sand specimens is shown in Fig. 4 and Table II. The sand C produced numerous large " buckle defects " on the cope side of a casting. Note how the outer surface of the sand specimen peeled off. This peeling took place immediately when the sand was inserted in a temperature of 1,370 deg. C. It was impossible to obtain accurate expansion readings of this sand because the specimen would break up as soon as it was inserted in the furnace of the dilatometer. The contraction of the sand specimen after the sides peeled off read − 0.022 in. To this same sand was added 2 per cent. of cereal binder, producing a marked improvement as may be observed in sand D. This improvement is due to the fact that cereal binder increases the flexibility of the sand. This sand has an expansion

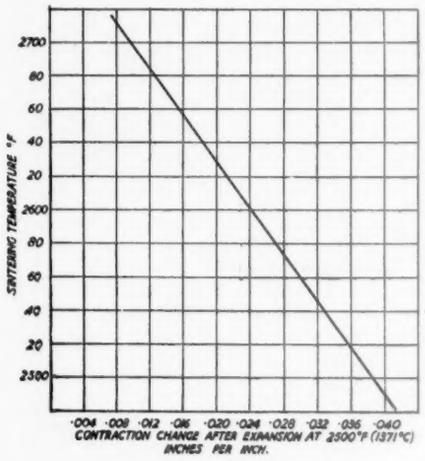
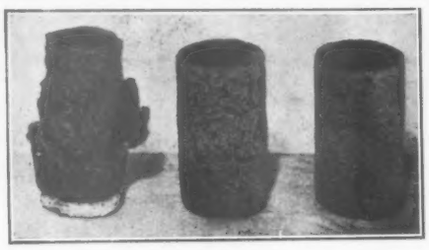


FIG. 6.—RELATIONSHIP BETWEEN SINTERING POINT AND LINEAR CHANGE IN CONTRACTION AFTER EXPANSION AT 2,500 DEG. F. FOR CRUDE AND WASHED SILICA.

of 0.008 in. and a contraction of − 0.012 in. The buckle defect is entirely absent in sand E where 3 per cent. of a clay bond was added to increase the quantity of contracting material. This sand has an expansion of 0.0145 in. and a contraction of − 0.009 in.

Correction of Scabs

A mould surface first goes through an expansion volume change and then through a possible contraction volume change. In Fig. 5 is shown a casting defect, a clearly-defined expansion defect (rat-tail), and also several small scabs. The amount that a sand will contract is probably most controlled by the sintering temperature of a sand. The contraction of a sand increases as the sintering temperature decreases. Fig. 6 gives a graphical presentation of this relation. Table III gives test data covering sand F which produced scabs, and sand G which did not scab. These two sands are composed of the same sand



C D E

FIG. 4.—CORRECTION OF BUCKLE (C) BY SUITABLE ADDITIONS (D AND E).

grains and type of bond. However, the sand F has a greater percentage of clay, resulting in a greater green and dry strength. Clay bond is a fluxing element in a sand, and the larger the quantity the lower the sintering temperature. Sand F has a sintering temperature of 1,290 deg. C., and sand G a sintering temperature of 1,420 deg. C. The dilatometer test shows that sand F expands 0.019 in and then contracts 0.028 in., while sand G expands 0.012 in. and contracts 0.011 in. As is shown in Fig. 7, the sand F will scab, while sand G will not produce scabs. The sand F may be improved by lowering the green strength to 7.5 lbs., which will increase the sintering temperature and reduce contraction.

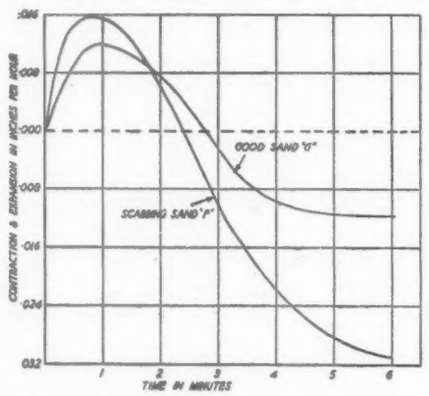


FIG. 7.—RELATIONSHIP BETWEEN LINEAR CHANGE AND TIME AT 2,500 DEG. F.

Material Control of Expansion-Contraction

The manner in which a sand is compounded yields a limited control of the dimensional stability of a moulding sand. A further control may be obtained by selection of materials used. The dilation curves, Fig. 8, covers the expansion and contraction of three different sands as temperature was gradually raised from room to 1,370 deg. C. The sand H shows a maximum expansion of 0.016 in. and a maximum contraction of 0.008 in. The sand H is a steel moulding sand of the type commonly used in steel foundries. The sand I is the same sand with

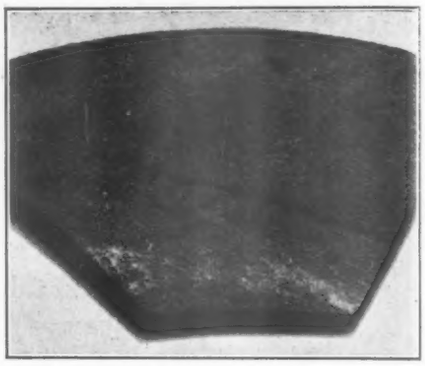


FIG. 5.—A CASTING SHOWING THE " RAT-TAIL " AND " SCAB " DEFECTS APPEARING AT THE SAME PLACE.

3 per cent. cereal binder added. The maximum expansion is reduced to 0.009 in. while contraction increased to 0.040 in.

A moulding material may be compounded that expands very little by using calcined clay particles for sand grains. Such a compounded sand

TABLE III.—*Properties of Sands F and G.*

(The sand F will cause scabs, while sand G will not produce scabs.)

Sand.	Moisture. Per cent.	Permeability.	Green compression. Lbs.	Dry compression. Lbs.	Resilience.	Sintering. Deg. C.	Expansion.	Contraction.
F ..	2.2	138	9.5	67	115	1,290	+ 0.019	− 0.028
G ..	1.8	143	6.6	77	92	1,420	+ 0.012	− 0.011

is sand J in Fig. 8, with a maximum expansion of 0.003 in. and a maximum contraction of 0.017 in. When a very refractory clay in used to bond the sand J, all of the contration may be eliminated up to 1,370 deg. C.

Conclusions

The expansion and contraction of moulding sand should be at a minimum to secure the best dimensional stability of the sand. When a moulding sand is used that has excellent dimensional stability, then greatest freedom from casting defects is obtained.

Subjecting sand specimens to shock temperature immersions of 1,370 deg. C. affords an excellent opportunity of observing visually how a certain sand mixture will behave in a mould.

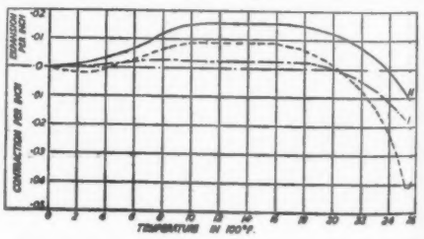
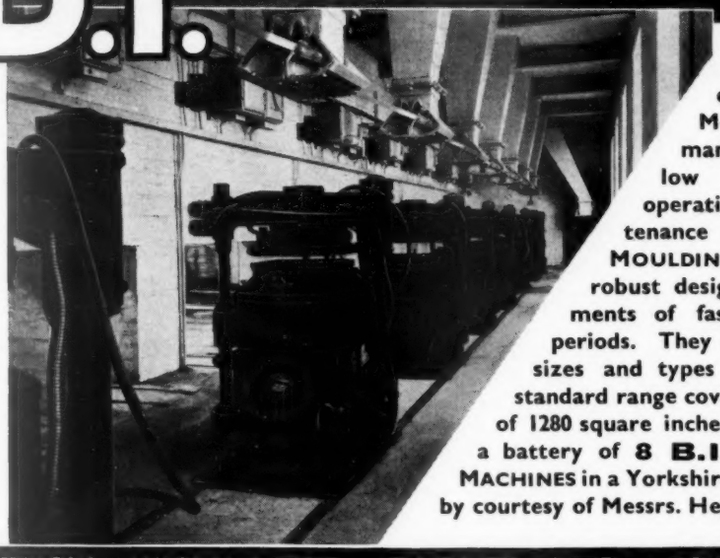


FIG. 8.—EXPANSION AND CONTRACTION OF SANDS H, I AND J UPON GRADUAL HEATING.

The expansion and contraction test on foundry moulding material will yield probably more practical information than any other test on sand. Through information obtained from such tests foundrymen will learn how to save the mould surfaces and save castings.

B.I. MAGNETIC MOULDING MACHINES *in a* YORKSHIRE FOUNDRY



ELECTRICITY, as the direct power medium for Moulding Machines, has many advantages, including low installation cost, low operating cost and low maintenance cost. **B.I. MAGNETIC MOULDING MACHINES** are of robust design to meet the requirements of fast production over long periods. They can be built for various sizes and types of moulding boxes, the standard range covering boxes up to an area of 1280 square inches. The illustration shows a battery of **8 B.I. MAGNETIC MOULDING MACHINES** in a Yorkshire Foundry, and is published by courtesy of Messrs. Hepworth and Grandage Ltd.

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The Week's News in Brief

Trade Talk

THE BENONI (SOUTH AFRICA) STEEL FOUNDRY has completed its new patternshop, and put into operation a new steel melting furnace and sand blast.

J. H. FENNER & COMPANY, LIMITED, of Hull, is opening, as from August 15, a branch office at Empire House, Great Charles Street, Birmingham, under the control of Mr. A. H. Royle.

THE ANGLO-IRANIAN OIL COMPANY have placed an order for three tug-boats with Ferguson Bros., Limited, Port Glasgow. This is in addition to eight vessels of a similar nature which the firm have built and are building for the same owners.

THE 1939 ANNUAL MEETING of the American Society for Testing Materials will be held at Atlantic City and in conjunction with it the Fifth Exhibit of Testing Apparatus and Related Equipment. The proximity to New York and the World's Fair has influenced this decision.

MR. J. LUTHER GREENWAY, of the Bradley Foundry, Bilston, on Thursday last opened the children's playing fields at Bradley, towards which he gave £1,000 to lay out and equip. Mr. Greenway was presented with a key to open the gates and the thanks of the Council and the Borough were extended to him by the Mayor.

THE 1938 AWARD of the Charles B. Dudley Medal was made to Mr. R. H. Heyer, member of the Research Department, The American Rolling Mill Company, for his Paper presented at the 1937 annual meeting of the American Society for Testing Materials on the subject "Analysis of the Brinell Hardness Test."

PRELIMINARY FIGURES for the consumption of aluminium in the United Kingdom in 1937 are given by the Aluminium Information Bureau as 44,000 long tons, in a report issued to-day. This figure represents an increase of 28 per cent. as compared with the consumption in the preceding year, and is more than 2½ times the quantity used in 1928.

PRESENTATIONS to Mrs. E. Brain, on the occasion of her 80th birthday, and to her grandson, Mr. Roger Brain, on his coming of age, were made by the staff and workpeople of Thomas Green & Company, Coseley Foundry, Bilston, last week. During the proceedings it was mentioned that the firm, which dates back to 1820, had three employees with over 50 years' service, seven with between 40 and 50, and 15 between 30 and 40 years.

THE SECOND of two 90-ton alternating stators, constructed for use at Glasgow Corporation Power Station, Dalmarnock, is now ready for delivery from Newcastle to Dalmarnock. The first stator was delivered about a year ago. The stator, which is 15 ft. 3 in. long, 11 ft. 10 in. wide, and 11 ft. 10 in. high, is considerably beyond the normal loading gauge of the railway, and special arrangements have to be made for its transport.

A NEW TYPE of oil container of spheroid form is to be manufactured under patent rights which are being acquired by the Motherwell Bridge & Iron Company, Limited. It is claimed that this globular tank will eliminate surface evaporation and cut out heavy losses in storage. The original patents, held by the Chicago Bridge & Iron Company, are being taken over by the Motherwell firm in conjunction with the Whessoe Foundry & Engineering Company, Limited, Darlington. The factory of the Motherwell company is being extended to cope wth the expected increase in orders.

THE SUCCESSFUL COMPETITORS for the four free trips to the Empire Exhibition in Glasgow, offered by Messrs. R. A. Lister & Company, Limited, of Dursley (Glos.), for the most original suggestion for an advertisement to advertise "Listard," are: Mr. J. D. Mills, London; Mr. Ian Gray, Dublin; Mr. W. Dresser, Edinburgh; and Mr. V. Morgan Watkin, Llangadock. In addition to the visit to the Empire Exhibition, in which Lister's have a special interest, as they are the firm which has supplied the auto-trucks which carry visitors round the grounds, the winners are to be entertained in Edinburgh, London, Stamford and Dursley.

WORK ON THE "QUEEN ELIZABETH" is so much ahead of schedule that all employees have been given at least ten day's holiday at John Brown & Company's yard, Clydebank. More than 2,000 tons of drag chains have been collected for launching the ship on September 27. The chains have been placed in position below the keel, and will be attached to giant hooks which have been fixed to the side of the vessel. The work of removing the construction blocks to enable the ship to rest on the launching ways has been almost completed. The estimated cost of the vessel is £4,000,000, which is cheaper than the "Queen Mary," mainly because of the use of the same berth, construction patterns, timber and other materials that were required for the older ship.

Company Reports

Mather & Platt, Limited.—Interim ordinary dividend of 4 per cent.

Blythe Colour Works, Limited.—Interim dividend of 5 per cent. on the ordinary shares.

Union Steel Corporation (of South Africa), Limited.—Interim dividend of 3 per cent.

Davy & United Engineering Company, Limited.—Net profit for the year ended March 31, £53,232; brought in, £21,859; dividend of 7½ per cent., £34,500; directors' additional remuneration, £2,662; carried forward, £37,930. Meeting, July 28.

Braithwaite & Company, Engineers, Limited.—Net profit for year to March 31, after depreciation and taxes, £28,425; to general reserve, £13,750; dividend of 2½ per cent. on the ordinary shares, £3,948; carried forward, after preference dividend, £25,475.

W. & T. Avery, Limited.—Net profit for the year ended March 31, £161,354; brought in, £65,080; preference dividends, £11,257; interim dividend of 5 per cent., £32,566; further dividend of 10 per cent., £62,462; to general reserve, £45,000; to pensions fund reserve, £10,000; carried forward, £65,149. Meeting, July 26.

Head, Wrightson & Company, Limited.—Profit for the year ended April 30, 1938, after charging debenture interest and providing for depreciation, £85,233; brought in, £7,420; reserve for pensions, £10,000; reserve for general purposes, £40,000; dividend on the 6 per cent. preference shares, £6,977; reserved for dividend on preference shares, March 31 to April 30, 1938, £613; dividend of 7½ per cent. and a bonus of 2½ per cent. on the ordinary shares, £22,837; carried forward, £12,225. Meeting, July 28.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Addalloy Metal Company, Limited.—Capital £2,000. Subscribers: E. F. O. Altenhein, 14, Park Lane, Sheffield; and C. E. Gray.

Manchester Metal Works, Limited, 363A, Bury New Road, Salford, Lancs.—Capital, £1,000. Directors: V. G. Van Colle and A. Hudson.

Lead, Brass & Iron Works, Limited, Holloway Chambers, Priory Street, Dudley, Worcs.—Capital, £100. Directors: J. Gough and G. H. Taylor.

Allied Iron (R. W.), Limited, Ketley, Shropshire.—Capital, £100. Directors: W. H. Watkins, T. O. Lander, W. H. Smith, J. H. Jones and L. A. Liddell.

Wednesbury Malleable, Limited, Berrington Chambers, 93, Tettenhall Road, Wolverhampton.—Capital, £500. Ironfounders. Subscribers: F. Cox and W. T. Rochelle.

Hiduminium (Developments), Limited, 89, Buckingham Avenue, Trading Estate, Slough, Bucks.—Capital, £10,000. To acquire in connection with the production of light metals or alloys letters patent, concessions, etc. Directors: W. C. Devereux, S. Sanders, F. J. S. Lawrence, J. Matter and P. Level.

Parkinson Stove Company's Mechanised Foundry

The freeing of the sand of all tramp iron is accomplished in this foundry by an overband electromagnet made by Electromagnets, Limited, of 48, High Street, Birmingham, 23, and not by the apparatus mentioned in the description which we printed on page 23 *et seq* of our July 14 issue. We sincerely regret the incidence of this error.

Personal

MR. FRANK S. RUSSELL has been elected a Fellow of the Royal Society of Arts.

MR. R. B. CLARK and Mr. W. Donald, of the fitting shop of Westburn Foundry, Arbroath, were presented with timepieces from their fellow workers on the occasion of their marriages.

CAPT. GEOFFREY SUMMERS has been appointed Deputy-Lieutenant for the County of Flint. Capt. Summers is managing director of John Summers & Sons, Limited, Hawarden Bridge Steelworks, Shotton.

MR. J. HOUGH, who has been for two and a-half years in charge of the British Cast Iron Research Association's experimental melting shop, has resigned to take a position with Broom & Wade, Limited, of High Wycombe.

MR. T. G. DELBRIDGE, manager, research and development department, the Atlantic Refining Company, Philadelphia, Pa., has succeeded Dr. A. E. White as President of the American Society for Testing Materials.

MR. F. W. G. HOBBS, of the Standard Brass, Iron & Steel Foundries, Limited, Benoni, South Africa, has arrived in London, and will remain in Europe for about two months. He is accompanied by Mrs. Hobbs and his son, who is taking an engineering course at Cambridge.

MR. C. ROWLEY has left the service of the British Cast Iron Research Association to take up the position of foundry manager with Johnsons Iron & Steel Company, Limited, of West Bromwich. Mr. Rowley joined the staff of the Association in 1928 as chief chemist, and was later attached to the Development Department.

MR. W. T. GRIFFITHS had the degree of Doctor of Science conferred upon him at the Congregation of the University College of Swansea on Saturday last. Mr. W. T. Griffiths, who is a native of Cardiff, for the past ten years has been manager of the research and development department of the Mond Nickel Company, Limited. He was responsible for the design and equipment of the Mond Nickel Company's research laboratory in Birmingham.

MAJOR F. A. FREETH, O.B.E., D.Sc., Ph.D., F.R.S., a past-President of the British Cast Iron Research Association, who has been Research Manager of Imperial Chemical Industries since the formation of the company in 1926, is retiring from that position, but has consented to continue his connection with the company in the capacity of consultant. Major Freeth, who comes of a military family, was educated at Liverpool University, and at an early age gained considerable reputation as a physical chemist, becoming chief chemist to Messrs. Brunner Mond & Company, Limited, in 1910. On the outbreak of the Great War he went to France with the Cheshire Regiment, but was recalled to England to undertake scientific work in connection with the supply of munitions. He rejoined Messrs. Brunner Mond, and for the remainder of the war he did very valuable work in developing new processes for the manufacture of explosives. For his services to the country he was honoured with the O.B.E. In 1924 Major Freeth was awarded the doctorate in the Faculty of Mathematics and Physics in the University of Leyden. He was elected a Fellow of the Royal Society at the early age of 41.

Wills

BROTHERHOOD, STANLEY, head of Peter Brotherhood, Limited, engineers, Peterborough	£382,934
CROSBY, W., formerly managing director and deputy-chairman of Edgar Allen & Company, Limited, Sheffield ...	£12,208
HEYWOOD, J. W., managing director of Heywood & Porteous, Limited, Gomersal, Leeds, engineers and ironfounders	£4,590

Obituary

MR. SAMUEL THOMAS GRESHAM, who, 40 years ago, pioneered the practical application of the vacuum brake, invented by his father, James Gresham, to the Indian railways, has died at Bramhall, Cheshire, aged 72. Mr. Gresham was managing director of the engineering firm of Gresham & Craven, Limited, of Salford.

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BIRMINGHAM OFFICE: 5, Lower Temple Street. Telephone: Midland 6376. Telegrams: "Genefax, Birmingham." (Mr. G. Griffiths)

Raw Material Markets

The iron and steel industries are experiencing a very quiet time at present. Many works are closed down for the holidays. Owing to the dull state of trade, generally, many concerns are prolonging their vacations. The Scottish Fair holidays are being taken now and a general resumption of work is being delayed until August 1. The impression prevails, and would not seem, perhaps, to be without foundation, that the autumn will witness an expansion of buying. It is unlikely, nevertheless, that orders will be more than of a hand-to-mouth character, as no incentive to buy is offered by the price situation. Lower prices are generally expected to rule after the turn of the year.

Pig-Iron

MIDDLESBROUGH. — The Cleveland pig-iron market continues to be quiet and any orders are readily supplied from existing stocks. Apart from a few small tonnages, the turnover is almost negligible, as most consumers have large stocks on hand, including quite a substantial tonnage of foreign iron. The loyalty rebate scheme now precludes the transaction of further business with overseas makers and consumers do not consider it worth while to forfeit their privileges under the scheme. In any case, the need to seek iron elsewhere is not now existent, as the largest orders can be despatched promptly by local producers. Cleveland No. 3 pig-iron is quoted at 109s. per ton for delivery on the North-East Coast. The output of hematite at present is considerably more than sufficient to meet the needs of all consumers. Most of the make is being used in producers' own furnaces, but large stocks are still on hand, and these are being steadily added to. Export business remains negligible. Local prices of hematite are much too high to encourage the placing of orders from abroad, as Continental quotations are substantially less than Cleveland prices.

LANCASHIRE.—Some of the consuming trades, which are better off as regards orders on hand, are taking up moderate tonnages of pig-iron under existing contracts, but, on the whole, there is little disposition to call for deliveries, as stocks at consumers' works are more than adequate to meet the current demand. Light-castings makers, textile machinists and jobbing founders, especially, are very quiet, and the hoped-for expansion of trade among makers of light castings does not appear to be materialising as had been anticipated. For delivery in the Lancashire price zone, offers of Staffordshire and Derbyshire brands of No. 3 foundry iron are on the basis of 114s. per ton, with Derbyshire forge iron at from 111s. to 113s., according to the class of consumer, and Northamptonshire No. 3 at 112s. 6d. No improvement is noticeable in the demand for hematite. West Coast material is on offer at 141s. and East Coast at 140s. 6d. per ton.

MIDLANDS.—Most of the light-castings founders remain on short-time working and there does not appear to be any likelihood of an early resumption of satisfactory employment in this section. In some other sections, also, trade is still quiet, and no expansion in the demand for pig-iron is coming forward. Forge pig-iron is extremely dull. On the other hand, activity in low-phosphorus iron continues to increase and larger quantities are regularly changing hands. Prices range from £5 15s. to £7, according to quality and the tonnage involved. The latter figure is for Scottish iron; owing to the high cost of this material, little business is being done. The call for contract deliveries of hematite is quite good, but, most users being well covered by contracts, there is not very much offering in the way of new business. Only a very small inquiry is in circulation for refined iron.

SCOTLAND.—No business has gone through during the past week, local steelworks and foundries being on holiday. It is certain that when operations are resumed there will be no expansion of buying, as consumers have supplies on hand which will last them for a considerable time at the present rate of consumption. The end of the year will be in sight before most consumers find themselves in a position to take up further supplies. Working time among the light-castings founders remains about three days per week. Orders on hand at local steelworks are satisfactory, but holidays extend up to the first day of next month. All prices are unchanged.

Coke

The coke market will remain quiet until the uncertainty regarding prices is dispelled. Although producers are still keeping to their fixed prices, which, they say, will remain in force up to the end of the year, consumers are of the opinion that these quotations are too high. For delivery to Birmingham and Black Country stations, best Durham coke is quoted at 50s. 6d., with Welsh coke at from 50s. 6d. up to 60s. 6d. per ton.

Steel

Although the trade is passing through the holiday period, and the demand for most steel products is on a restricted scale, the tone of the market is well maintained. A more optimistic feeling is in evidence, and the inquiry in some departments has become more active. These tendencies point to a revival in business in the early autumn rather than a broadening in the demand during the holiday period, but the outlook now is regarded as being more encouraging than at any time since the first part of the year. The demand for semi-finished steel is quiet, and in this department, also, considerable reserves are weighing upon the market. A certain amount of productive capacity remains idle, but there has been a marked reduction in the imports of foreign semis, and consumers' stocks are being steadily absorbed. The improvement in the tone of the market is chiefly noticeable in the finished steel section, and recently business upon home account has shown signs of developing. Export business is not easy to arrange, and overseas consumers do not seem inclined to undertake fresh commitments.

Scrap

Business is almost at a standstill in the iron and steel scrap market. Practically all grades are similarly affected and merchants' stocks are steadily accumulating. Efforts are being made in some quarters to obtain a return to free marketing of scrap, including the removal of export restrictions.

Metals

The outlook on the non-ferrous metal markets, generally, continues to be of an optimistic nature, despite the fact that there has been no outstanding business done.

Copper.—The American situation is playing an important part in deciding the trend of the copper market in London. While it is considered that there are prospects of a recovery of industrial activity in the United States, it is known that consumers there have been in the market recently for supplies which must last them for several months, and, consequently, the likelihood of a continuance of business on a scale approximating to that of the past few weeks is remote. The maintenance of the strength on Wall Street has also helped to keep the London market firm. The use of copper in the building industry is expanding, but the plans passed for the larger structures, in which copper is chiefly utilised, continue to be on a disappointing scale. The Ministry of Labour returns for June, referred to in our last issue, indicate that, while plans passed for housing schemes are satisfactory, the number of larger structures which are being erected is still on the small side.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £39 16s. 3d. to £39 18s. 9d.; Friday, £40 8s. 9d. to £40 10s.; Monday, £41 3s. 9d. to £41 5s.; Tuesday, £41 5s. to £41 6s. 3d.; Wednesday, £41 11s. 3d. to £41 12s. 6d.

Three Months.—Thursday, £40 3s. 9d. to £40 5s.; Friday, £40 13s. 9d. to £40 15s.; Monday, £41 8s. 9d. to £41 10s.; Tuesday, £41 10s. to £41 11s. 3d.; Wednesday, £41 16s. 3d. to £41 17s. 6d.

Tin.—A firm tone has persisted in the market in this country, but new buying remains rather quiet. In the United States, similar conditions are ruling, and, while business is on the small side, the tone, generally, is quite confident. The American tin-plate mills continue to operate at a very unsatisfactory level and difficulty is being experienced in procuring new orders. Most of the mills are in possession of heavy tonnages of tin, which are not likely to be reduced very substantially until there is a revival of activity. Reference to the tin buffer pool was made by Mr. Ernest V. Pearce, chairman and managing director, at the annual meeting of Consolidated Tin Smelters, Limited. He said that the question of restriction of output was one for the decision of tin producers only. If the object of the buffer pool, which was in reality a producers' pool, could be attained, it should prove to be of immense value both to producers and consumers. The welfare of the tin industry was dependent on general trade prospects in the tin consuming countries, especially the United States; where there were signs of some return to confidence in recent weeks.

Official quotations were as follow :—

Cash.—Thursday, £193 15s. to £194; Friday, £194 to £194 5s.; Monday, £194 15s. to £195; Tuesday, £194 7s. 6d. to £194 10s.; Wednesday, £194 to £194 5s.

Three Months.—Thursday, £194 15s. to £195; Friday, £195 to £195 5s.; Monday, £195 15s. to £196; Tuesday, £195 5s. to £195 15s.; Wednesday, £195 5s. to £195 10s.

Spelter.—Little change is taking place in this market from week to week. In sympathy with other metals, the tone of the spelter market remains quite firm, but there continues to be only a moderate amount of support from consumers. Although the absence of any official news is causing disquiet in some quarters, it is generally believed that there is no reason to anticipate that the efforts to revive the International Zinc Cartel have broken down.

Daily market prices :—

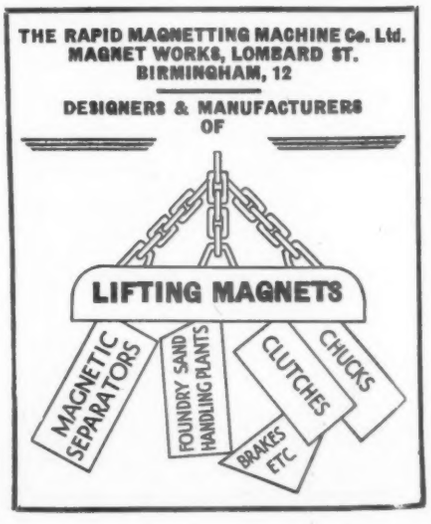
Ordinary.—Thursday, £14 1s. 3d.; Friday, £14; Monday, £14 6s. 3d.; Tuesday, £14 3s. 9d.; Wednesday, £14 3s. 9d.

Lead.—This market remains quiet, with prices maintained. In the United States, business has been quite satisfactory of late and some heavy tonnages are changing hands.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £14 10s.; Friday, £14 12s. 6d.; Monday, £14 18s. 9d.; Tuesday, £15 2s. 6d.; Wednesday, £15 6s. 3d.

Aluminium.—The recent reduction in the price of aluminium, which was reported in our last issue, has occasioned no little surprise. It is nearly six years since the quotation was fixed at £100 per ton, this figure being subject to a discount, which recently has been about 2 per cent. The new level of £94 had not been anticipated, and the current strength of base-metal prices, generally, makes the cut in the price of aluminium even more welcome. In future, higher premiums will be commanded by finished and semi-finished aluminium products. Rolling slabs have been reduced in price by £3 to £97 per ton. Sheet prices remain unchanged. It is believed in New York that a cut will shortly be made in the price of aluminium there.

Scrap.—During the past week, business has been rather disappointing. It had been hoped that there would shortly be an expansion in the demand for non-ferrous scrap, but this has, so far, failed to materialise.

Approximate selling prices for old metal :—New aluminium cuttings, £72; rolled, £55; cast, £28; foil, £88. Copper, £37 to £40; braziery, £33. Brass (clean), £21 to £24. Zinc, £9. Lead, £14. Gunmetal, £39.